2017

Socialization of Engineering Doctoral Students in the U.S: A Phenomenological Study

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SOCIALIZATION OF ENGINEERING DOCTORAL STUDENTS IN THE U.S.: A PHENOMENOLOGICAL STUDY

by

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A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy
in the College of Education and Human Performance
at the University of Central Florida
Orlando, Florida

Spring Term
2017

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ABSTRACT

The purpose of this study was to describe the lived experiences of doctoral engineering students' socialization with their advisors and colleagues. Using snowballing sampling methods, eleven students with research or teaching assistantship from three engineering programs from a large University in the Southeastern US agreed to participate. Face-to-face interviews were audio-recorded, descriptively transcribed, and analyzed using a variation of Colaizzi's method. Participants experienced difficulty adjusting to the workplace norms of the PhD program, which some did not start with clear expectations. Some participants lacked work experience before starting, but were thankful for support from more experienced doctoral students. Most participants were also frustrated by unreasonable time demands and heavy workload around deadlines. Participants were hesitant to share concerns with their advisors, fearing repercussions. Through trial and error and assistance from labmates, participants learned to work independently and become problem solvers. Participants from one rapidly changing and competitive field of engineering experienced additional stressed as they tried to keep pace with scholarly advances and publish more research. Participants' experiences corroborate some prior research about doctoral student socialization, but suggest that engineering their socialization was guided by a constellation of role models and not primarily by their advisors. Also contrary to prior research, even though most participants were international students, they did not experience significant difficulties with cultural adjustment to the US. Their cultural adjustment was aided by large number of other doctoral students from their region of the world and the fact that they had little time to venture out of their labs. Suggestions for future research are discussed.

To dad, and his lifelong devotion to teaching, and all the dreams he had destined for me.

To Karim, and his persistence and his smiles

ACKNOWLEDGMENTS

This dissertation was about the stories of some engineering doctoral students who trusted me, a stranger, with so many of their stories, thoughts, concerns, and smiles. A hundred pages or so is not enough to fully reflect their experiences, nor express the amount I am thankful for their trust. They placed their trust in a student-turned-researcher walking the hallways of their college, an IRB Explanation of Exempt Research (Appendix B) in hand, seeking willing participants.

The participants shared both positive and challenging experiences, and in many moments while listening to their audio-recorded voices I found myself dreaming of a utopia in higher education. A utopia that every researcher is sure will never come to exist, but may have dreams of moving slightly towards. In thinking about that utopia, I came up with different wishes and dreams: I wish for every doctoral student to experience at least one course in their graduate life that opens a new window to their research interests; a course to a never-expected-to-exist window, a true gift for their entire life. I wish for them a course that provides a new lens through which to see the world; if they could be fortunate to see what was shared with me, a lens not only to understand human research subjects differently, but to see all human life differently. I wish for all to experience a course with surprising content, challenging assignments, fruitful-guided discussions, and a patient instructor. An instructor like I had, whose students from a variety of academic backgrounds would enthusiastically wait in a long line after each class to ask their questions, each receiving sharp responses from a holistic mind who connects journal articles, books, and new relevant topics to their ideas-- always with a smiling face. Thank you, Dr. Boote, for teaching EDF 7475, Qualitative Research in Education! And thank you for serving as the chair of my committee,

and remaining a knowledgeable, caring, and understanding “role model” for me throughout this dissertation process!

Thinking again about that utopia, each student deserves to have at least one strong, selfless professor and/or program coordinator. Someone who, with a warm smile taps on their shoulder the very first day of classes of the first semester, making them sure that the student feels supported from the beginning all the way until the end of the program. Thank you Dr. Jeanpierre, for all the great support you gave me during the ups and downs of my study!

In this utopia, graduate students can stop by the offices of associate deans and directors of the College of Graduate Studies and speak openly. They can rest assured, knowing that they are supported and that they can rely on faculty members and Graduate staff for support regarding research and general graduate student concerns and questions. Thank you for your support during the past year and a half, Dr. Jasinski, Dr. Parham!

This next vision for a higher education utopia is not a requirement, but it would be a welcome addition. This situation is about finding a graduate program you think you love, and yet after checking the requirements multiple times, still feeling scared because you, better than anyone else, know how novice you are in a field. So then you just start walking around the physical space of the college for days, but never with courage enough to enter the building. Then one day, close to the entrance of the building, you start talking with a stranger who turns out to be a professor of that college. This person listens to your story, probably feels how scared you are, and then with a big smile encourages you to apply for the program you love. Thank you, Dr. Owens, for listening to me that day! Thank you, Dr. Butler, for being the first person in the College who trusted the novice but enthusiastic person that I was!

Thinking about not only a utopia for graduate students, but a utopia for every one, I wish for all students to have loved ones, and a kind, strong and supportive family. During the past few years, seeing my family's faces on SKYPE, hearing their voices on the phone calls, and reading their familiar words and jokes on text messages always put a smile on my face. Even living in three different continents of the world, I knew that they were with me: my mom, my siblings, Soodabeh, Roozbeh, and Mina; my niece, Negaar; and my uncle Daie Ali. To me, the best day is the day we could sit again all together behind Mom's dining table to talk, laugh, and simply be together.

May the beautiful campus of University of Central Florida, a University well-known for large numbers of students, one day remember two of those students. A couple, both of whom earned a PhD in 2016-- one from the College of Education and Human Performance and one from the College of Engineering and Computer Science. This couple stayed long after office hours on campus for a few years, each working in his/her own office on opposite sides of the campus, with specific quiet spots to meet for lunch together and talk about their day. One was me, Sona, always talkative, full of hopes, fears, and sometimes tears. One was him, my partner, Karim Alizad, who was also full of hope, but with a great patience and inner calm; not only a great listener, but a critical listener always with thorough questions. Thank you, Karim, for the true love given, and the persistence to never stop believing in me! Without you, and without my mentors I've written about, this dissertation would not exist.

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CHAPTER ONE: INTRODUCTION

Problem Statement

The U.S. engineering job market presents an immediate need for scientists and engineers who have already adapted to U.S. customs and norms. At present, large populations of engineers and scientists are close to retirement, and too few students are graduating from universities with engineering or science degrees to backfill the vacant positions (Nelson, Brammer, & Rhoads, 2007). In addition to the gaps among engineers in general, engineering doctoral graduates are in high demand. Over the course of the last twenty years, the ratio of engineering doctoral recipients to total doctoral recipients has increased from 8.9% in 1993 to 17% in 2013 in the United States (National Science Foundation, 2013). This increase represents a significant change in this population and warrants a closer examination of how engineering doctoral students adapt to the norms and practices of engineering colleges.

The research on the education of scientists and engineers tends to focus on technical aspects of their training and research preparation. However, research on doctoral education suggests that technical training is not the only or even necessarily the main determinant of the success of doctoral students (Bair & Haworth, 2004). Indeed, Bair and Haworth's meta-synthesis of qualitative research on doctoral attrition and retention indicate that social and cultural issues are the primary determinants of success (2004). More generally, Ellis, Bauer, and Erdogan (2014) suggest that organization's socialization processes largely determine members' attitudes towards their job, quality of performance, and organizational turnover (Ellis et al., 2014). In the context of this study, successful socialization influences the dropout rate of doctoral students, which is estimated around

40 to 60 percent in the last five decades (Nerad & Cerny, 1991; Tinto, 1987/1993). This number is significant due to the prediction that there will be a shortage of qualified professionals for the overall engineering job market in the future (Nelson et al., 2007).

Part of the reason for concern for successful doctoral student socialization, in addition to the human cost, is the monetary expense of doctoral education in engineering. The overwhelming majority of doctoral students' in engineering are funded, most often by funding from engineering research projects. In turn, the expectations of continued funding may encourage engineering faculty to engage engineering doctoral students in writing research proposals, and govern their expectations and assigned workload. In some instances, the faculty expected workload of the international students may be excessive. Moreover, when university graduate education policy is perceived as a key supportive agent, assisting graduate student in early recruitment processes and informing them of their rights and responsibilities, this may further affect international students willingness to ask faculty mentors questions about work expectations as it is then under the shadow of a graduate student bill of rights.

The multifaceted key term, socialization, in my argument needs to be elucidated because of different nuances of meaning associated with domestic and international student behaviors. Entering a doctoral program, both domestic and international students are considered newcomers to doctoral level norms and practices including research integrity, ethical behaviors, and professional relationship with advisor and peers (Golde, 1998). Being raised in the same culture, domestic students might not have as much difficulty understanding and interpreting some of the required norms and principals, such as research integrity and conflict of interests. However,

entering a new research group for international students typically occurs simultaneously with becoming a new member of a new culture and location. Therefore, international students not only struggle with adapting to doctoral research norms, but may also need to adapt their mindset, identify and differentiate multitude of rules, regulations, and cultural dimensions associated with the new setting. As a result, domestic and international students' socialization processes may differ. So, while the term socialization is usually referred to as multiple processes, this study focuses on the organizational socialization process. This more subtle aspect is important because when joining a doctoral program, domestic and international students face opportunities and challenges to interact with a new advisor, research group, college, and university.

Compared to other fields, the population of temporary visa-holder doctoral students in engineering represents the most dominant group of international students, representing 52% in 1993, and 56% in 2013 (National Science Foundation, 2013). Nelson, Brammer, and Rhoads **(**2007) argue that welcoming international students in engineering majors at universities solves the anticipated shortage problems in the future engineering workforce. However, the authors concluded that increasing the numbers of international students in university engineering programs does not guarantee that U.S. values and interests will continue to be represented in the workforce, nor that international students will remain in the U.S. post-graduation (Nelson et al., 2007). I concede this point by Nelson et al. (2007); however, I believe that socialization of international students to U.S. work norms and values will increase their success rate and would serve to overcome the authors' conclusions about this segment of the workforce.

Bauler and Taylor (2001) argued that since most organizational socialization theories are developed by western researchers, the theories do not necessarily reflect the socialization process of diverse populations. This is important for my research because describing the behavioral dynamics of doctoral students with varied backgrounds may identify variations from mainstream socialization theories that may currently exist. Through the development of "modern and postmodern versions of culture and socialization" (Tierny, 1997, p. 2), higher education organizations provide opportunities for people with different cultural or ethnic backgrounds to bring their culture to the organizations and co-create a new culture in the postmodern approach. The practice of embracing contradictions and uncertainties to the organizational culture stands in stark contrast to that of the modern socialization approach, which classically argued for socialization as a one-way process. This unidirectional process occurs when newcomers to an organization acquire knowledge by completing a set of planned activities (Tierny, 1997). Moving toward a postmodern approach has enabled the field to identify organizations as agents that "honor differences rather than [assimilate]" diverse cultures in "organizational melting pots" (p. 7). The postmodern perspective produces a better understanding of the reciprocal process of socialization. In light of my own research, the differences and contradictions that doctoral students from diverse backgrounds experience in the engineering college will be described.

According to Ellis et al. (2014) who made significant contributions to organizational socialization studies, the reciprocal process of organizational socialization incorporates several factors under two categories: influence of inside members and organization on the newcomer, and effects of new members on the organization. Reviewing previous organizational socialization

theoretical frameworks in "Socialization in different relationships and settings" (2014), the authors highlight the outcomes of newcomer's adjustment:

> Adjustment indicators represent proximal outcomes of the socialization process and include role-clarity, self-efficacy, social acceptance, and knowledge of organizational culture. Thus, successful organizational socialization occurs when organizational efforts and individual behaviors effectively address and aid in the development of these indicators. (Ellis et al., 2014, p 315)

Effective socialization of engineering doctoral students should result in deeper understanding of students from their organizational culture and may increase their ability to succeed. If the argument of Ellis, Bauer, and Erdogan (2014) is right about the result of the reciprocal interaction of organization and new employees, then socialization of engineering doctoral students will be reinforced through objective alignment, transparency, and feedback among students, advisers, colleges of engineering and universities.

A phenomenological approach will allow an examination of students' lived experience and support structures and barriers to students' socialization in engineering colleges. This may prompt further questions about how engineering doctoral students learn to adapt appropriate norms of research in the field and draw attention to specific barriers international students face. As a result of using a qualitative analysis, I seek to expand the student-faculty interaction literature within the engineering education context. This qualitative study approach will allow us to see how cultural elements systematically can shed light on various dimensions of faculty and international student performance compared to several quantitative studies that focused on partial student academic

achievement variables such as English language proficiency, self-efficacy, and academic stress level (Santiago & Einarson, 1998; Wan, Chapman, & Biggs, 1992; Xu, 1991).

Purpose of the Study

The purpose of this study is to describe experiences of engineering doctoral students. An intended outcome of this research will be to provide details about interaction experiences of domestic and international engineering doctoral students with colleague and advisors that support and challenges students' adaptation to doctoral program. The research will describe how doctoral students adapt to the norms and values of the program.

Research Question

This research is a phenomenological study, and the central research question for this study is developed as the following in the alignment with purpose of phenomenological research:

What are the lived experiences of doctoral engineering students' socialization with their advisors and colleagues?

Research Design

The focus of this study as a phenomenological research is to describe the experiences of engineering doctoral students. The purpose of a phenomenological research is to understand individuals' experiences of a phenomenon and meanings individuals ascribe to their experiences (Creswell, 2013; Husserl, 1954; Moustakas, 1994).

Assumptions of the Study

The first assumption of the study is that the eleven participants who agreed to participate, were willing and comfortable to share their thoughts and concerns in an in-person face to face

interview. The second assumption is that all the participants are Graduate Teaching Assistant or Graduate Research Assistant, and receive financial support from their advisor or the college.

Definitions of the Study

International student: is a student "who is not a citizen, national, or permanent resident of the United States and who is in this country on a visa or temporary basis and does not have the right to remain indefinitely" (Alum, 2013, p.2).

Socialization: refers to a mechanism that supports new members to acquire values, beliefs, and norms of a new social group (Mortimer & Simmons, 1978).

Organization of the Study

In Chapter two of this study, the researcher synthesized the relevant literature related to each sub-area.

In Chapter three, the researcher discussed methodology of research, rationale for the design, sampling procedure, interview process, and data analysis procedures.

In the next chapter, the researcher provided participant biosketches and discussed description of the findings.

In Chapter Five, corroboration and contradiction of the findings with the findings is discussed as well as limitations of the study and recommendations for future research.

CHAPTER TWO: LITERATURE REVIEW

Introduction

In this chapter, the literature on socialization of doctoral students will be reviewed, primarily focusing on student-advisor relationship. First, a review of literature on organizational socialization will investigate socialization of doctoral students, in terms of new comers to the new campus, and socialization of international students, in terms of sojourners to the U.S. In the next step, the researcher will review the pertinent literature on student-faculty relationship in general, and how the study of graduate students' interaction with faculty has evolved in particular. Exploring engineering education literature, the chapter will be concluded by review of qualitative research background in engineering, with a focus on the culture of the field.

Search Strategy

The study utilized an exhaustive search strategy to include relevant scholarly articles. The initial area of research for the current study involved advisor-advisee relationships among domestic and international graduate engineering students. However, a preliminarily search of electronic academic databases available at the University of Central Florida library found few pieces of high-quality research in this area. Several articles focused on issues of international engineering students in the graduate school, using quantitative methods. The articles, usually using quantitative methods, revolved around a variety of issues of graduate international engineering life including student academic self-confidence and academic self-efficacy (Santiago & Einarson, 1998), socio economic status (Millett & Nettles, 2006), and engineering college attrition (Lovitts, 2001; Millett & Nettles, 2006).

Finally, adapting the term *Socialization* and examining the broader contexts, the topic was redefined at the intersection of four broad areas of research: higher education, engineering education, socialization, and intercultural communication. To identify relevant issues and scholarly articles within the subject areas, this researcher referenced the most recent handbooks published within each content area (Grusec & Hastings, 2014; Johri & Olds, 2014; Paulsen & Smart, 2013), in addition to the electronic sources at the University of Florida Library. The articles which were not in English language or available through the University of Florida library and Interlibrary Loan & Document Delivery Services were excluded from the search process. The findings from the literature review are presented in the following subsections.

Socialization of Newcomers

New comers experience major challenges while entering to a new organization. A successful transition occurs when new comers effectively learn shared values and practices of the new organizations. Research suggested that socialization is a mechanism that supports new members to acquire values, beliefs, and norms of a new social group (Mortimer & Simmons, 1978).

Organizational socialization, as a type of socialization, refers to a continuous process that newcomers are inducted into an organization's culture (Van Maanen & Schein, 1979), and the "process by which newcomers make the transition from being organizational outsiders to being insiders" (T. N. Bauer, Bodner, Erdogan, Truxillo, & Tucker, 2007), p. 707). That is a process with interrelated elements that involve individuals and groups at different organizational levels. So that, newcomers seek information from established members to learn the necessary knowledge and skills to operate in new organization, fulfill the requirements of the new job, and communicate

with their colleagues. At the same time, the organization attempts to stimulate newcomers to embrace its culture (T. Bauer, Morrison, Callister, & Ferris, 1998). Organizational socialization research is focused on how to make the learning process of newcomers more smooth, and how to assess the learning outcomes of new organizational members (Ellis et al., 2014).

The reciprocal nature of socialization is developed in the literature. Classically, the socialization process was assumed as a one-way process that has to be done from the person being socialized by "acquiring" organizational norms and value through doing certain set of activities (Tierney, 1997). The traditional concept of organizational socialization tactics was developed by Van Maanen and Schein (1979) that refers to the following six dimensions: (1) collective versus individual socialization (2) formal or informal socialization (3) sequential or random training steps (4) fixed or variable sequencing of training (5) serial or disjunctive tactics and (6) investiture or divestiture (Van Maanen & Schein, 1979). Accordingly, the aforementioned tactics were suggested to be arrayed in a different way, institutionalized (collective, formal, sequential, fixed, serial, and investiture) and individualized (individual, informal, random, variable, disjunctive, divestiture) (Jones, 1986).

Socialization in Higher Education

Graduate students learn values, norms and practices of programs through formal and informal interactions with colleges and advisors. A vast amount of research explored aspects of how graduate students socialize within the programs or disciplines. Research suggested that socialization is an ongoing process in both undergraduate and graduate levels that results in the building of students' professional identities, an alignment between the goals of students and programs, and high-quality interactions between faculty members and students (Bragg, 1976).

However, a significant number of college students do not return to the college after their first year of study (Horn & Carrol, 1998). Research identified a positive association between the regularity and quality of informal student-faculty interactions and (a) students' motivation to complete their degree, (b) interest in their major, and (c) communication with other students (Pascarella, 1980). According to Tinto's (1987) integration theory, the extent that students interact with faculty and engage in college activities significantly influence school's attrition rate, and also reflect the health of the school's social environment. Although the theory is well regarded and "near paradigmic status" in higher education literature (Braxton, Milem, & Sullivan, 2000, p. 107), researchers argue that Tinto's theory failed to consider cultural barriers and the limitations of racial/ethnic minority students in integrating with the new school (Guiffrida, 2005; Kuh & Love, 2000). Researchers argued that "integration can mean something completely different to student groups who have been historically marginalized in higher education" (Hurtado & Carter, 1997, p. 4).

Socialization of International Students

Engineering disciplines at U.S universities are among the majors that annually admit several high-achieving students from inside and outside of the country. Numerous studies have explored various aspects of challenges sojourners experience. The research about sojourner socialization began to develop in 1960's, due to an increasing number of international students participating in exchange programs and growing overseas trade in the postwar period (Kim, 2002). Studies have investigated consequences of culture shock, and psychological difficulties sojourners face during the cross-cultural transition such as feeling of isolation, and depression (Oberg, 1960; Ward, Okura, Kennedy, & Kojima, 1998). Other researchers argued that sojourners experience a subtle process of learning and self-awareness, adapting to the new culture (Adler, 1975).

A theory of *U-curve hypothesis* has been used and developed in several research as an essential basis to analyze sojourners' psychological and behavioral dynamics (Furnham, 1988; Ward, Okura, Kennedy, & Kojima, 1998). According to the theory, sojourners' adaptation process typically starts with excitement and fascination to the new culture, continues with a disintegration phase, and ends up in recovery (Kim, 2002). A study of Norwegian scholars adaptation in the United States (Lysgaand, 1955) suggests that,

> Adjustment as a process over time seems to follow a U-shaped curve adjustment is felt to be easy and successful to begin with; then follows a crisis in which one feels less well-adjusted, somewhat lonely and unhappy, finally one begins to feel better adjusted again becoming more integrated into the foreign community. (p. 50)

Research suggests that students have different interpretations of their institutional culture based on their cultural/ethnic background. As such, Tierney (1997) argued that one form of socialization cannot be applied to all students,

An organization's culture is not internally coherent to all individuals. People are not all alike, and their joining together in an organization suggests that they are involved in the creation - not the discovery, not the duplication - of culture (Tierney, 1997, p. 7).

Socialization of Doctoral Students

Despite substantial research that has been conducted on reasons of undergraduate student attrition, fewer scholars studied doctoral student retention in graduate programs. Further, the literature in socialization of doctoral students is predominantly focused on persistence and attrition. Research suggested that doctoral students are in a continuous process of sharing experiences with each other that supports learning and the internalization of skills, judgements, and responsibilities

required for their field (Bragg, 1976). That is, to gradually form the professional identity of doctoral students within the groups (Bragg, 1976). Research suggested that graduate school consists of "confirmation through socialization of preexisting behavior tendencies." (Bess, 1978, p.312). However, socialization is described from the position of the socialized person in the five following steps:

1. Identification and observation of a role model.
2. Imitation of specific behaviors exhibited by the role model.
3. Feedback and evaluation on the imitated behaviors.
4. Modification or refinement of the behaviors that were evaluated.
5. Internalization of values and behaviors from the role model (Bragg, 1976, p. 7).

Cooperative relationships between doctoral students and faculty members creates a research environment that promotes mutual understanding, high efficiency of academic work, and students entering research-based professional roles (Weidman & Stein, 2003). Teaching assistantships and research assistantships also provide valuable opportunities for doctoral students to learn norms regarding teaching and research norms in their field (Austin, 2002). However, teaching assistantship opportunities are described as unstructured (Austin, 2002) in terms of "lack of developmentally organized, systematic professional development opportunities" (p.105) and "few opportunities for guided reflection" (p. 106).

Associating dropout issue in the higher education with the lack of socialization, Tinto (19987/1993) argued that a less number of research in doctoral students attrition have been conducted comparing to undergraduate students, because

> Research on graduate attrition has not been guided either by a comprehensive model or theory of graduate persistence or by the methodological strategies that have been successfully employed in the study of undergraduate persistence. (p. 231)

Student-faculty Interaction in Higher Education

Several studies have explored aspects of student-faculty interaction in higher education, emphasizing the outcomes of this relationship to undergraduate students (Crisp & Cruz, 2009; Pascarella, 1980). The main critique about the student-faculty interaction research, specifically those studied students' outcome, is that a large number of them are not constructed based on or developed a theory (Jacobi, 1991; Johnson, Rose, & Schlosser, 2007). The researchers noted "many of the frequently cited studies in this area utilize surveys to simply gauge the frequency of satisfaction with mentorships. Fewer studies work to link method with theory; the most highly refined theoretical models of student faculty mentoring have rarely been researched" (Johnson et al., 2007, p. 52). Further, the authors proposed that student differences influence the link between student-faculty interaction and students' academic outcomes (Johnson et al., 2007, p. 52). As such, research suggested gender-based differences in students' academic identities, expectations, and self-esteem, depending on the extent and frequency of interactions with faculty (Sax, Bryant, & Harper, 2005). A qualitative study of mentors' personal preferences and motivations to select protégés pointed out that "mentors will perceive that there are greater rewards to providing mentorship to protégés who are perceived to be similar to themselves than protégés perceived to be dissimilar to themselves" (Allen, Poteet and Burroughs, 1997, p. 86).

Graduate Students' Interaction with Faculty

Doctoral students practice research norms and professional behaviors through socializing with adviser, research group, and college. Faculty relationships with graduate students are both similar to and different from relationships with undergraduate students. The relationship is similar in terms of mentoring and different in terms of the duration of the interactions; and a higher level of emotional interrelations between faculty member and graduate students (Austin, 2002; Tenenbaum, Crosby, & Gliner, 2001). In the last two decades, large research universities have received criticism on the inadequacy of advising and mentoring programs for graduate students (Arum & Roksa, 2011; Zusman, 2005). Large research universities tend to place a greater emphasis on tenure-track faculty conducting research and bringing funding to the university rather than teaching and mentoring undergraduate and graduate students (Arum & Roksa, 2011; Zusman, 2005). Mentoring graduate students serves as a socializing agent that facilitates students' adaptation to graduate life (Cole & Griffin, 2013). Graduate students' socialization is a process by which graduate students learn values, norms, and practices related to their research and field of study (Belcher, 1994; Kirk & Todd-Mancillas, 1991; Weidman, Twale, & Stein, 2001). Through a relationship with faculty, graduate students gain knowledge about their discipline and the associated nature of research in the field (Cole & Griffin, 2013). Moreover, faculty members provide graduate students with valuable insights into the professional and career paths that are available (Waldeck, Orrego, Plax, & Kearney, 1997). Guiding students through the dissertation process, faculty members support graduate students to present their research findings in academic conferences and professional gatherings. Through mentoring, faculty members expand graduate

students' skills in developing ideas, applying appropriate methodologies, and communicating results (Baird, 1995).

Qualitative Research in Engineering

Traditionally, performances of engineering students and the college have been measured through quantitative methods, reflecting the relation of limited number of variables. The quantitative methods were assumed as the only right method to measure academic outcomes, because of congruency with usual problem-solving approaches in engineering field. With the inclusions of qualitative methodologies to engineering education in recent years raised the motivation of investigating the culture of engineering. Researchers explored cultural elements of engineering education such as engineering identity, gender, and campus culture (Dryburgh, 1999; Tonso, 1996; Tonso, 2006).

Researchers in social sciences expanded the use of qualitative research methods and relevant examples in engineering (Creswell, 2007; Merriam, 2002; Patton, 2005). However, methodological discussion does not receive sufficient consideration in the engineering education literature (Koro-Ljungberg & Douglas, 2008). Insufficient methodological discussion in a field results in the notion that "methodology is tactically accepted as a given, meaning that one methodology is implicitly assumed to be the right one" (Case & Light, 2014, p.536) which limits the expectations of the research community to findings from a specific methodology. The predominant research in engineering education is traditional quantitative research, enabling the researchers to develop numerical predictive models (Case & Light, 2014). In starting a dialogue among quantitative, qualitative, and mixed method research in the engineering education context, researchers noted that "engineering educators who have been trained primarily within the

quantitative tradition may not be familiar with some of the norms of qualitative research" (Borrego, Douglas, & Amelink, 2009) p. 56). One study investigated the methodological approaches taken in an international engineering education journal and found few published articles using a qualitative research design (Koro-Ljungberg & Douglas, 2008). Additionally, the articles in the journal using a quantitative methodology rarely provided a theoretical justification for their study design (Koro-Ljungberg & Douglas, 2008).

Culture of Engineering

Most of the engineering education research, both quantitative and qualitative, have been about undergraduate students, studying academic performance and student-faculty relationship. However, during recent years, multiple studies investigated partial elements of engineering education culture such as engineering identity, gender identity, campus culture, and national culture (Courter, Millar, & Lyons, 1998; Downey et al., 2006; Dryburgh, 1999; Lattuca, Terenzini, & Volkwein, 2006; Karen L. Tonso, 1996; Karen L Tonso, 2006). Table 1 presents some of the studies.

Table 1 illustrates the methodological details about exemplar studies focused on engineering culture. Culture of engineering was studied in a longitudinal ethnographic research project at an engineering school at a high rank research university in New Zealand. " (Gofrey & Parker, 2010, p.5). The purpose of the study was analyzing the culture aiming to generate a framework to map the relationship of cultural elements based on identifying "where we are" and "how to get where we want to go" (Godfrey & Parker, 2010), p.5). The significance of the study is that it demonstrated six cultural dimensions for engineering education. The authors argued that although the concept of "culture" are widely studied in a variety of educational contexts, the

discussions about the culture of engineering education are recent additions to the literature in the past ten years.

Table 1: Summary of Research and Data Collection Strategies for each Engineering Cultural Element

Cultural Element	Studies	Population	Focus	Data Collection Strategies
Engineering identity	Dryburgh, 1999	Female undergraduate Students in engineering	- Adapting to the professional culture - Internalizing the professional identity	-Observation - Focus groups - Interview
Student engagement	Lattuca, Terenzini, & Volkwein, 2006	Engineering students, program heads, faculty, and alumni	Student learning outcomes	Survey
Campus culture	Tonso, 2006	Engineering undergraduate students	Influence of campus culture on males and females teamwork interactions	- Observation - Interview
Sub-disciplinary cultures	Gilbert, 2009	Doctoral students and professors in mechanical engineering and materials science	Gendered practices and identities in different disciplines	-Observation - Interview

Note. Adapted from "Understanding Disciplinary Cultures: The First Step to Cultural Change," by E. Godfrey, 2014, *Cambridge Handbook of Engineering Education Research*, Cambridge University Press, pp. 437-453.

Previous research documented an existing common and distinct engineering culture (Bucciareli, Einestain, Terensini, and Walser, 2000; Tonso 2006), describing that the preeminent engineering culture is formed by "compartmentalization of knowledge, individual specialization, and a wholly research-based reward structure" (Bucciarelli et al., 2000, p. 141) and low participation of women (Dryburgh, 1999; Lewis, McLean, Copeland, & Lintern, 1998).

However, the nature of the integrated culture was previously challenged to recognize differences in beliefs and patterns of behaviors in various disciplines of engineering (Williams, 2002). Based on the ethnographic data gathered from an engineering campus, the research proposed the following six cultural dimensions: (a) An Engineering Way of Thinking, (b) An Engineering Way of Doing, (c) Being an Engineer, (d) Acceptance of Difference, (e) Relationships, and (f) Relationship to the Environment (Godfrey & Parker, 2010), p.5).

Conclusion

The experiences of domestic and international engineering doctoral students is a multifaceted topic that connects various research areas, including: socialization, qualitative research, engineering education, advisor-student relationship, and sojourners' experiences. Doctoral students as new comers to Ph.D programs need to acquire values, norms and practices. Graduate teaching and research assistantship positions provide opportunities for doctoral students to learn disciplinary norms of their field. Student-faculty relationship in doctoral level deeply influence students' performance due to significant amount of interactions and strong affectional bonds between students and advisors. Professional identity of doctoral students forms within research groups based on the interactions students have with their advisors and colleagues. That is, to direct

students to observe and identify role models and internalize new values and norms in the doctoral programs.

To define the domain of the study, the researcher conducted a pilot study in Fall 2014, Spring 2015, and Summer 2015, in addition to the literature review. Further, the pilot study informed her about recruitment process and possible limitations for the current study.

Pilot Study

The purpose of the study was to obtain a cultural perspective of how graduate female students in engineering perceive their gender identity. Conducting this pilot study motivated the design of this dissertation and its focus.

The study had an ethnographic design and was conducted using observations and in-person interviews. The participants were graduate female students from the department of Civil, Environmental, and Transportation Engineering. Graduate female students were observed in the building hallways and graduate offices. Observational data was collected about students' appearance, professional behavior, language used, and interactions with their peers and surroundings. Participants received the informed consent document prior to the interview and learned details about the nature of the study and goals of the researcher.

Multiple facets of the pilot study informed the researcher on graduate engineering culture, and helped her to narrow down her research focus and define the domain of the dissertation topic. Prior to obtaining IRB for the pilot study, my initial goal was to understand how cultural differences between the College affect the way female students express their gender. Receiving feedback from my professor, I gradually learned how to add detailed descriptions of observants' activities to my field notes. Recording reflective notes in addition to descriptive notes allowed me

how to capture my thoughts, judgments, and questions during observations. Focusing on smaller groups of students, I observed different language use and patterns of behaviors between students in the Eng. II atrium and students in the hallways of the College.

For the pilot study, I conducted observations and interviewed female students in both master program and doctoral program of College of Engineering. Listening to the audio-recorded interviews and transcribing them, I learned to ask more in-depth questions to encourage participants to move beyond providing generalizations and instead share detailed examples of their thoughts.

The recurring problems of the one master-level student and the only first year doctoral student were formed around courses and communicating with their peers in class. However, the other six doctoral students mostly talked about difficulties they had in interaction with faculty and research group. These two different themes of the problems motivated me to narrow down my research to describe the doctoral students' socialization with peers and advisors rather than the broader area of graduate students.

Finding common themes among international student such as lack of integration with the college and feeling overwhelmed entering the college by new expectations motivated me to define a new domain for my dissertation, considering behavioral dynamics among and between domestic and international students and faculty.

CHAPTER THREE: METHODOLOGY

Purpose of the Study

The purpose of this study is to describe experiences of engineering doctoral students. An intended outcome of this research was to provide details about interaction experiences of domestic and international engineering doctoral students with colleagues and advisors that support and challenge students' adaptation to doctoral programs. The research will describe how doctoral students adapt to the norms and values of the programs.

Research Question

The focus of phenomenological research design is individuals' experiences of a phenomenon and meanings individuals ascribe to their experiences (Creswell, 2013; Husserl, 1954; Moustakas, 1994). The central research question for this study is developed as the following in the alignment with purpose of phenomenological research:

What are the lived experiences of doctoral engineering students' socialization with their advisors and colleagues?

Methodology

As a movement and as a research method, phenomenology was immensely influenced by Edmund Husserl (1859-1938), a German mathematician and philosopher. As suggested by Husserl, in phenomenological study the researcher selects a human phenomenon and gathers data from individuals who experienced that phenomenon. The output of a phenomenological study is a description that reflects participants' "essence" of experience, containing details of "what" each individual experienced, and "how" that experience occurred (Moustakas, 1994).

Phenomenological research has two major approaches; descriptive and interpretive phenomenology (Lopez & Willis, 2004). Both approaches will be discussed in this section.

Descriptive phenomenology was established by Husserl based on two main assumptions (Husserl, 1970). The first assumption was that *we can only know what we experience*. That is, the researcher is merely responsible to collect individuals' description of experiences, rather than assuming or seeking an ultimate truth for the phenomenon. The main focus of Husserl's argument was that experiences needed to be investigated similar to how scientific constructs are explored, emphasizing the objectivity of the researchers. The concept of "epoche" or "bracketing" is a suggested strategy developed by Husserl to identify researchers' biases (Drew, 1999). Therefore, prior to start of a phenomenological study, researchers identify their own beliefs and personal knowledge about the phenomenon and provide a thick description of personal biases, achieving a comprehensive description of the researchers' subjectivity (Natanson, 1973). Husserl also suggested another underpinning assumption for descriptive phenomenology, the existence of common features among individuals' lived experiences. Therefore, the goal of the researcher is to identify those commonalities and then develop a generalized description of the studied phenomenon (Lopez & Willis, 2004).

The second approach of phenomenology is the interpretive research tradition that was established by Heidegger to challenge some assumptions of the descriptive approach (Cohen, 1987). The fundamental assumption behind interpretive phenomenology is that participants are not always consciously aware of what they know, so the researcher must interpret the meanings from participants' narratives (Salomon, 2004). Heidegger (1962) used the term *lifeword* to imply that individuals' experiences are constantly under the influence of the word they live in. These

experiences should be analyzed through narratives of participants' everyday experiences. In interpretive phenomenology, researcher's personal knowledge is used as a helpful and necessary aspect that guides the research (Heidegger, 1962).

Research Design

The design of this study followed the descriptive phenomenology approach to guide the purpose, research question, and data analysis process. The researcher was trying to remain objective about the data collection and analysis, consistent with descriptive tradition. Moreover, the findings of the pilot study indicated that participants to some extent were aware and thoughtful in expressing their experiences and the meaning of those experiences (i.e., what they learned from those experiences).

Conducting a pilot study helped the researcher to gain a better understanding of how engineering students interpret and describe their experiences. Participants of the pilot study were generally aware of their experiences and typically provided examples and descriptions of their daily norms and habits. These findings guided the researcher to view phenomenology research design as a potential methodology. As the goal of the researcher in the current study was to investigate experiences of engineering doctoral students, a phenomenological research design was adopted to allow the researcher explore how the participants interpret their experiences of engineering doctoral program.

The main purpose of a phenomenological study is to develop a comprehensive meaning from participants' experiences (Creswell, 2013).

Population and Sampling

The population of the research was doctoral students in computer science, computer engineering, and electrical engineering programs in the United States.

The sample examined in the study included eleven doctoral students in computer science, computer engineering, and electrical engineering programs at a large urban research university in the Southeastern U.S. The doctoral students were located in one building at the university. To be included in the study, participants were 18 years of age or older, worked as graduate teaching assistants and graduate research assistants within the college, and were currently enrolled in one of the three Ph.D. programs in Engineering.

To identify potential participants, a snowball sampling was used. Prior to the current study, the researcher conducted a pilot study in the University to understand the perceptions of female engineering graduate students related to their gender identities. The pilot study suggested that participants, especially the international students, would be much more likely to agree to participate if they had some kind of personal connection with the researcher. The researcher's background as an international student with engineering background and a husband completing his PhD in another Engineering department helped her in gain access to a sample that was reluctant to speak openly with outsiders. However, in this study, the researcher did not wish to include participants who she knew previously. The researcher was also aware of the potential problems that may resulted from snowball sampling, such as creating a biased sample based on similarity of ethnicity, gender, or country of origin between participants and researcher. Therefore, the researcher asked her social network to recommend her to other students in the targeted PhD

programs. As a result, the researcher contacted multiple students with various backgrounds in an effort to reduce the possibility of a biased sample.

To ensure an adequate sample, data collecting continued until the experiences reported by participants showed noticeable similarities. In addition, the researcher tried to create a sample that was roughly representative of the population of doctoral students in these three PhD programs with regard to gender, country of origin, and years in the program. Data saturation was reached after interviewing eleven participants where significant commonalities among participants' experiences were found. The final sample was diverse, but under-represented women and Chinese students within the three PhD programs.

Data Collection Procedure

In the first step of data collection procedure, the researcher obtained the Institution Review Board (IRB) approval from the University of Central Florida Office of Research and Commercialization (Appendix A). The research was classified by the IRB as "exempt" due to minimal risk of the study and exploring an "established or commonly accepted educational settings, involving normal educational practices." Therefore, instead of asking participants to sign an Informed Consent form, the researcher explained the purpose of the study and provided participants with an IRB approved Explanation of Exempt Research (Appendix B), prior to each interview.

The interviews were in-person, in a mutually agreeable location, face-to-face, semi-structured, and audio recorded. To have a confidential and private discussion and minimize

the breach of confidentiality, the interviews with participants were conducted in the researcher's office space.

Prior to the interviews, the participants were informed that the interviews were audio recorded, and the recording would be kept in a locked, safe place. The interviews lasted from 45 to 60 minutes, except for two interviews that lasted longer as the participants were interested to elaborate more details. The interviews were conducted during a time that were mutually agreed upon by the researcher and the participants.

Data confidentiality was further safeguarded by the researcher removing the participant names and other personally identifying information on all records. Each participant was assigning a unique identifier and participants' identities were stored the in a physically separate place from the data. The deidentified files of the interviews were password protected and maintained in a secure database, separate from related data files.

The interviews were semi-structured. As such, the interviews were focused on nine predetermined questions. The researcher only asked the sub-questions when participants did not spontaneously provide that information when answering the main interview questions. The interview questions were refined after the pilot study. The following is the list of questions and associated sub-questions were asked from each participant:

1. Please describe your academic background before starting the PhD program.
    a. Why did you decide to start the PhD program? What perspective and expectations you had?

2. How would you characterize your experience as a PhD student?
3. How your initial expectations from the program aligned with your current position?
4. Please describe your daily activities in the college.
    a. How much time is allotted for each activity?
    b. With whom do you interact daily the most (Personally and professionally)?
    c. What new norms have you adopted as a doctoral Student?
    d. Who are the people you interact the most? Describe your interactions with them.
    e. What challenges you have interacting with them?
    f. Which part of your work do you like most?
    g. Which part of your work do you like least?
5. Please describe your work norms.
    a. What norms have you adopted from your adviser?
    b. What norms have you adopted from your research group?
    c. What routines you have for your work? Do you work on weekends?
    d. Please describe the factors that influence your daily decision making process?
    e. What are the main factors that lead your decisions at school?
    f. To what extent, if at all, is the decision making process dependent upon outside influence (i.e.: advisors/peers/etc.)?
6. What problems have you had during your doctoral studies?
7. Please describe if you have had any problems interacting with your lab mates, research group, and advisor.
8. Describe your interactions with your labmates.

a. How do you describe your interactions with your international student lab mates? (If the participant was a domestic student)
b. How do you describe your interactions with your domestic student lab mates? (If the participant was an international student)

9. How do you compare the work norms you learned here with what you had in your home country? (If the participant was an international student)
    a. What challenges you had learning the new norms?
    b. Why you decided to apply for this university?
    c. During the application process, who were the people you asked most for help?

Data Analysis Procedures

The researcher of this study followed the step-by-step phenomenological analysis example provided by Sanders (2003) as a benchmark that applied the Colaizzi's framework. In this section, an explanation will be provided on how these steps were conducted in this study, followed by an introduction to the suggested steps by Colaizzi,

In the first step of the data analysis, the researcher listened to each audio-recorded file twice Colaizzi suggested verbatim-transcription of audio-recorded data, however, the researcher used descriptive transcription technique in this study, due to the limitations of verbatim-transcription suggested by research such as fraught with time consuming, resource intensive (Britten, 1995), and human errors (Easton, McComish, & Greenberg, 2000). The researcher undertook reflective journalizing immediately after each interview as a strategy for self-reflection and then listened to each audio-recorded interview several times to capture most important meanings generated by each participant (Halcomb & Davidson, 2006). In the next step, listening

to each participant's audio recorded file, the researcher excerpted several groups of statements which together created the whole meaning of participant's experience. Colaizzi has named these statements as "significant statements". In the third step, the researcher interpreted the meanings of each significant statements in two or three sentences. In the fourth step, the meanings were categorized to initial themes of overlaps and interrelationships. The relevant themes were categorized in five major themes and 23 sub-themes in a frequency table. Consistent with the methods of descriptive phenomenological analysis suggested by Coliazzi and others, there was no direct connection between the blueprint for the interview protocol and final themes. Instead, the coding and analysis emerged organically rather than following a pre-determined set of categories as one would do in other inductive approaches to qualitative research.

In the fifth step, the core argument of each sub-theme was formed by incorporating selected relevant quotations, formulated meanings and pieces of self-reflection. In the sixth step, the researcher used this information to develop a narrative, describing each subtheme separately. The researcher did not return to the participants as Colaizzi suggested, but instead used the method of ensuring trustworthiness of the findings and analysis discussed in the next section.

This study adapted a variation of Colaizzi's seven-step method to analyze the research data. Table 2 provides an overview of the Colaizzi method (Sanders, 2003) and how it was adapted for this study.

Table 2: Adaptation of Colaizzi method for data analysis

Stage	Colaizzi's recommended process	Adapted analysis process
1	Acquiring a sense of each transcript	Listened to each audio-recording multiple times
2	Extracting significant statements	
3	Formulation of meanings	
4	Organizing formulated meanings into clusters of themes	
5	Exhaustively describing the investigated phenomenon	Collected relevant quotations, formulated meanings and pieces of self-reflection for themes
6	Describing the fundamental structure of the phenomenon	
7	Returning to the participants	Reviewed by two external auditors

As the first stage, Colaizzi recommended for researchers to read participant's entire story to obtain a meaningful feeling of his or her lived experience. Haase and Myers (1988) suggested researchers listen to the audio-recorded participants' voices multiple times. In the second stage, Colaizzi (1978) suggested researchers read the transcripts more than once and extract the statements by which they will use to highlight the most important parts of each participants' lived experiences. In the third step, Colaizzi recommends finding the meanings behind the general statements in the previous stage. The next suggested step is converting the meanings found in the last step to clusters of themes. The fifth step for the researcher is to provide the description of the texture, which is the experience participants described, for each cluster of theme Colaizzi (1978). In the sixth step, an essential structure, the context in which participants had their experiences, will be developed through consisting of the processes and meanings from that last step (Haase & Myers, 1988). The final step is validating the process through returning to the participants to assure the findings corroborate with their experiences (Colaizzi, 1978).

Trustworthiness of Research Findings and Analysis

Three processes were employed in this study to improve the trustworthiness of data analysis and findings. In the first process, the researcher asked an external auditor, a Science Education doctoral student at UCF, Jonathan Hall, to review the results provided in the frequency table. The external auditor randomly selected one sub-theme from each theme, and checked their occurrence in the raw data. To a great extent, the results found by the external auditor were similar to the findings suggested by the researcher. However, the external auditor reported a different frequency for one of the sub-themes. Therefore, the researcher returned to the data, provided a more accurate wording for the sub-theme, and counted the frequency one more time.

In the second process, an explanation of the major and sub-themes was provided to an advanced Computer science doctoral candidate as a form of member check to verify that themes and sub-themes were consistent with his own experiences and knowledge of other students' experiences. The external auditor verified the authenticity of the themes and sub-themes. He acknowledged that although he personally had a different experience for one of the themes, but she verified that the majority of students' experiences might be similar to the reported themes.

In addition to the two method of trustworthiness outlined in the previous section, the researcher provided a description of her personal knowledge about the phenomena, prior to the start of data collection. This bracketing process was then used throughout data analysis to ensure that the researcher was not simply validating her prior beliefs and expectations. Therefore, this is a third means of ensuring trustworthiness.

Bracketing

During the period of this study, I was a PhD student in Science Education program in the College of Education and Human Performance at the University of Central Florida. As a citizen of Iran, I am considered an international student. In Iran, I earned an undergraduate degree in civil engineering and a masters degree in industrial engineering. At the time the data were collected, my husband was a PhD student in engineering in another department of the College in which the data were collected. During data analysis, he completed his doctorate and started a postdoctoral fellowship in engineering at another university.

My experiences, biases and assumptions may have impacted my role as a researcher. Possible biases could be related to my nationality, gender, and academic background. I have had several graduate engineering friends and most of them were international students who typically worked long hours in their labs. As a result, thinking about an engineering graduate student the first image that comes to my mind is an international student experiencing work pressure. However, my assumptions about this topic were formed based on my friends' lived experiences, and indeed, their experiences do not reflect engineering graduate students' experiences in general.

Furthermore, as an Iranian, contacting Middle-Eastern students may have been easier for me. Some potential participants could not be comfortable sharing their experiences with outsiders, specifically with researchers from other countries or regions of the world. I personally do not have any biases regarding contacting and communicating with students coming from different countries, ethnicities, or religions.

As a female student, it might be easier for me to contact female students, and female students might have been more comfortable sharing their experiences with another female

researcher. For the purpose of data collection of my pilot study, I contacted several female graduate students and they shared with me many details of their graduate life. As a result, I expect that several female participants would agree to participate in this study as well.

As a researcher with engineering background, I knew that many engineering doctoral students work by their computers and have little verbal interactions with their labmates. As far as I know, some of them have habits of speaking to the point, using common lingual codes, and do not provide details during verbal communication. Some similarities may exist in this regards between my participants and me that may affect the data collection process and interpretation of data.

When I started the data collection, I did not have a clear understanding of the specific differences among doctoral programs in electrical engineering, computer engineering, and computer science. I knew typically electrical engineering and computer science graduates receive higher salaries on average than do graduates in other engineering fields. In addition, I always had an impression that since the job market for graduates from electrical engineering and computer science programs provides for above-average compensation, graduates who decide to pursue advanced degrees probably have strong motivation to conduct research, as they are less likely to be motivated by compensation. Additionally, based on my own experiences in my home country, I had noticed that these two majors had generally higher levels of difficulty and complexity compared to other engineering fields, and electrical engineering and computer science were among top performing students in their programs or schools.

During the past few years living in the U.S. I have had many friends who were engineering doctoral students. Speaking with my friends and engaging in a variety of events in the engineering

college such as dissertations defenses and workshops, I learned that most of the engineering doctoral students are not domestic students. Most of the students seemed to be from Asia, the Middle-East, and India. Most of the international students who I know have research assistantships or teaching assistantships, working with professors on projects funded through collaborations with companies outside the university. As far as I heard from my friends, graduate assistants usually work with an adviser in the first semester, some with a co-adviser, belong to a research group and work in shared office spaces with other members of the research group, and sometimes with other faculty's graduate students. I have had friends who were doctoral engineering students and often worked on their computers in cubicle offices, where they often code and program. Most of the time when my friends were talking about their work, I imagined them spending many hours in the labs working with computer, having limited interactions with their lab-mates and research group.

I am aware that there is a common belief among engineering doctoral students that majority of international students are full-time students at the College with teaching or research assistantship. However, most of domestic students are part-time students and do not have full-time jobs at the College. My impression is that there might be a desire from faculty to hire students from the same region due to the ease of communication with students from similar culture, having familiar work norms, and common patterns of behaviors. This could result in low English language proficiency of some of the engineering graduate students.

Prior to start the PhD program in science education, I entered my current university with an PhD admission in the College of Engineering, and then after one semester quit that program. At the time of applying for that engineering doctoral program from outside of the U.S., I personally, as an international student had an initial interest to contact professors from my home

country. That is why I have the impression that it might be similar for other prospective doctoral engineering students. Such an inference may be valid for domestic doctoral students as well. As an international student, I understand the important role of financial support in graduate students lives, and believe some international students may experience extra work pressure due to fear of losing their financial support or visa.

I have heard from my friends who are engineering graduate students, especially international students, that they have limited opportunities to socialize with students with other backgrounds, learn about their preferences and work norms, or share their own challenges. The slow or impaired enculturation of doctoral engineering students may result in consequences such as changing advisers and research areas,

International students who have teaching assistantship or research assistantship are required to work twenty hours per week and are paid biweekly for a twenty hours workload. However, I have heard some students complain they were usually required to work more than twenty hours. Additionally, I am aware that many international students have limited interactions with their family in their home countries due to the limitations in visa issue, long distances from the home countries, and expensive airfare fees.

The following is a list of my prior beliefs and possible biases with engineering doctoral students and their work experiences:

- Work in cubical offices, coding and programming
- Work hard and stay long hours in the labs
- International students have limited interactions with their labmates.
- International engineering students experience additional work pressure.

- Female students will readily agree to participate in the study.
- Most domestic students are part-time students and do not have full-time jobs in the College.
- International students with teaching or research assistantship are required to work more than twenty hours per week and are paid biweekly for a twenty hours workload.
- Most of international students are full-time students and have full time jobs in the College like teaching assistant or research assistant.
- Impaired enculturation may result in changing advisers and research areas
- Students may be more likely to be hired by faculty from the same region of the world.
- International students in doctoral engineering programs typically have low English language proficiency.

International students have limited interactions with their family in their home countries due to difficulty in visa issue.

As will be seen in the analysis of data, some of my prior knowledge was challenged, some were reinforced, and some topics I did not anticipate emerged from the data.

A comparison of my biases and prior beliefs is presented at the end of Chapter 4.

The research methods described in this chapter were used to collect and analyze the data, resulting in the findings reported in Chapter 4.

CHAPTER FOUR: FINDINGS

The purpose of this chapter is to provide a description for the lived experiences of engineering doctoral students socialization with their advisors and colleges. In this chapter, the researcher presents participants' biosketches, a thematic analysis for the 11 participants, and a description of findings.

Participant Biosketches

Table 3 represents participant demographics.

Table 3: Participant Demographics

Gender	
Male	10
Female	1
Degree program	
Computer science	5
Computer engineering	3
Electrical engineering	3
World Region	
Indian sub-continent	4
Middle East	4
Asia	1
North American	2
Years in program	
2 to 3	7
4 to 6	4

Amir

Prior applying to the program, Amir gathered information about studying in the US from her friends who were already students in the US. Amir feels her experience is similar to what she expected in terms of workload of research and coursework. She describes her interaction with advisor as "okay," when she does not meet a deadline is the advisor is usually okay. She describes interactions with her lab mates good because she can share her frustration. She describes her experience of doctoral degree as "not very good," since she has received many rejections from journals and conferences.

Lily

He describes the PhD life as a process that influenced different aspects of his life, including quality of relationship with family and personal health. He criticized the excessive pressure on graduate students to publish, and describes this as norm of his advisor and research community. He describes his relationship with lab mates as "friendship."

Ali

He described his interactions with his lab mates "friendly" and the interaction with his advisor "in one word: professional". He believes that advisor has high expectations from students, so that encourages students to work more and do a quality work. His major problem program is that he has to work more than the hours limit mentioned in the graduate assistantship contract.

Nilla

His expectations from the program was taking courses and doing research, consistent with his experience except that the workload is more than what he expected. He did not expect to have any difficulty in the coursework and he did not. Overall, he is happy with his PhD experience. However, he has had challenges interacting with his advisor. He never has had difficulty interacting with either international or domestic students in the lab or on campus.

Dena

His experience did not match his expectations. He mentioned that he received much destructive feedback from his professor. He recalled and mentioned many occasions of experiencing offensive language, humiliation, threats of contract and visa termination.

Haily

Even when he was a bachelor student, he had a great interest in the field which is the focus of his current research. However, doing research has never been intuitive to him. After receiving his master's degree, he participated in many job interviews, but did not find a job that he desired. Reviewing the job requirements, he learned that most of the well-known companies in his field need research background. Therefore, he made the decision to apply for the PhD program.

Ryka

Before he started the program, he expected to learn a lot of knowledge in his field in the PhD. However, during his study he learned that the aim of PhD is not teaching students everything, but gives them skills to solve real-world problems. He enjoys the fact that the projects they are working on in the lab link research to industry. He described his lab atmosphere

as “friendly” and stated that everybody in the lab is willing to help and support each other. He feels that the adviser puts a lot of stress on himself, however Ryka works more effectively when he is relaxed and not under stress.

Keyana

He had no idea what PhD would be when he started the program. He learned academic professional behavior, social and communication skills, and problem-solving skills in the program. He describes his advisor as welcoming, calm, and patient, and stable in his behaviors.

Nicki

He enjoys studying as a PhD student and feels he has a great interaction with his advisor. He also enjoys the nature of being graduate student that makes him able to manage his own schedule. As his advisor and lab mates are international, he wished he had an opportunity to interact more with domestic students. He has a good interaction with his advisor; however, always there is a huge gap between him as a novice researcher, and advisor as a professor.

Reza

He expected to receive professional training in a well-developed academic program. He also wants to have a very competitive CV that could support him to find jobs in either academia or industry. His current status is pretty much what he expected, and he has met almost all the requirement of the program and also his own expectation. His interactions with labmates are focused on mentoring undergraduates and newer graduate students.

Samin

He entered the program because he had a great research experience during his masters. Also as a result of the interacting with university professors in the conferences he attended during his masters he decided to be part of the research community. He truly enjoys his experience as a PhD student, and feels every day he is getting better.

Description of Findings

In this section, the findings of the study are presented. The main research question of the study was "what are the doctoral engineering students' lived experiences of socialization with advisors and colleagues?" Analysis of the data revealed the participants experiences could be clustered in 5 main themes, each with associated sub-themes The themes and subthemes are presented in Table 4. The fifth theme "Challenges of studying in a fast-moving field" was found from the computer science participants' experiences and is discussed later in this Chapter.

Difficulty Adjusting with New Work Norms

Participants experienced difficulty learning research and PhD program norms, mostly attributed to their lack of clear expectations for the program and their lack of previous employment experience. Additionally, some participants described that they were hesitant to contact their advisors and ask their questions.

Lack of Employment Skills

One of the participants, Nilla, stated, "I have not had the experience of working with others. For the first time… I practiced professional behaviors in a workspace: how to manage distractions, how to communicate, collaborate, and manage relationships." He also emphasized

difficulty accepting his advisor's role, stating that his advisor's main common message in all the conflicts is that the advisor is the "boss." A lack of employment skills influenced participants' perception of advisors' roles. Coming to the PhD program directly from bachelors and having a mindset of professor as an "instructor," led him to have a hard time perceiving the professor's roles as both an "advisor" and a "boss."

Table 4: Frequency of Participant Experiences by Cluster Group

Major and Minor Themes	Typical	Frequent	Variant
Difficulty Adjusting with New Work Norms			
Lack of employment skills		X	
Lack of clear expectations from the program		X	
Hesitant to share work concerns with advisor			X
Contrast with engineering work			X
Interacting with Advisor			
Trusting advisor for making research decisions	X		
Perception of role models			X
Referring to opposite cases		X	
Inconsistent with American work values			X
Managing Advisor's Expectations			
Advisor aims high		X	
Unreasonable time demands	X		
Lack of collaboration			X
Work pressure around deadlines	X		
Unwilling to receive criticism			X
Difficulty reaching out the advisor		X	
Learning to Work Independently			
Labmates support each other	X		
Learning from labmates' experiences	X		
Learning through trial and error	X		
Becoming problem solver		X	

Note. Typical = 9-11 participants; Frequent = 4-8 participants; Variant = 1-3 participants

Lack of Clear Expectations from the Program

One common element among participants experiences was that, prior to starting the program, none expected to have difficulty in coursework, and their experience matched the expectations. However, the program turned out to be longer than what they expected, and contained a heavier workload. Lily stated: “I thought that it [PhD] is kind of a longer version of masters; it is not quite that... and I had a vague perspective when I started the PhD program; I just knew it's about doing research”. Moreover, the lack of clear expectations, in some cases, were related to the lack of preparations for the program. As Keyana stated “In the first year, I didn't have any idea what research is, I even did not know the meaning of key terms of research like model, literature, references.” Unaware of a need for a strong mathematical basis for his research, the research process was extremely complicated for him.

As Nicki explained “To be honest, I did not have any expectation of how the PhD program is going to be”; he started the program without any expectation. Rather than considering program requirements, receiving funding was the main reason some participants chose the PhD program. As Nicki describes: “Basically, I had zero expectations when I was coming here, if they would get me funded, I would be happy, that was enough.” Complaining about department decision making processes, he talked about difficulty managing his Teaching Assistantship work, Nicki stated “My department do not determine your background when they want to assign you the teaching assistantship position”, neglecting the fact that he himself did not have any expectations when he entered the program.

Hesitant to Share Work Concerns with Advisor

Two of the participants described that they usually do not share their work concerns with their advisors. One other participant, who had decided to quit the program due to conflicts with his advisor, mentioned that he usually did not share his concerns with the advisor. He never wanted the advisor to think that he is complaining or disrespectful, emphasizing "I am respecting him based on my own personal and cultural values". He is an international student, and when he talked, he constantly expressed that he is confused understanding his advisor's behavior. This seems to suggest nuances in defining "sharing concerns," "complaining," and "disrespecting" in some cultures. These concepts may be easily intermingled by some students and professors. Understanding the complex nuances of hierarchical relationships may create communication barriers between students and advisors, specifically for international students, or domestic students working with professors originally coming from other cultures.

One of the participants only once decided to share his concerns with his advisor, expressing that he feels that the advisor is like a "father" for him. However, from this participant's cultural perspective, viewing his advisor like a father suggested his reluctance to admit that the student did not understand something for fear of disappointing his advisor. His relationship with his advisor was more akin to a child-parent relationship rather than a mature dialogue or interaction. Three of the participants mentioned that their advisors had bad tempers and were not tolerant of criticism. In some cases, concern-sharing experiences for participants have resulted in consequences and even punishments, so that they preferred not to openly discuss their work issues with advisors. Several participants mentioned that these penalties result in a constant pressure and encouraged

them to seek support from labmates. This behavior also prevented them from clearly understanding and addressing advisors' expectations.

Contrast with Engineering Work

Undergraduate engineering lessons generally consist of many repetitive procedures, including mathematical and computational calculations. Two of the participants, who had engineering work experience prior to starting the PhD program, expressed that the engineering work included repetitive procedures as well. While few participants had clear expectations of the requirements of graduate research, two participants were motivated to start PhD program for the novelty of research work. Keyana stated: "After my bachelors when I started working, I got so bored; it was about repeating some certain tasks over and over. All the technology was imported from abroad; our job was only maintaining the technology, no opportunity for research or development." Samin described why he enjoys doing the research work: "In general, my experience is good. What I do is a combination of work and research. It is not pure science, or is not like engineering jobs, which are just about repeating some tasks." However, as discussed below, research work is complicated and quite different from the repetitive work of undergraduate or professional engineering work, and most participants had difficulty adapting to the research worked expected in the PhD program.

Summary

Participants of this study, especially when they were new to the program, experienced difficulties adapting to the work requirements of the program. Participants needed guidance on how to manage initial phases of research work and how to also communicate effectively with their

advisors. These work and communication problems arose because of participants lacked clear expectations from the program and employment skills. These resulted in participants' difficult interaction with their advisors and the professors whom they worked for as Teaching Assistants. Despite these problems early in the program, with time and experience in the program, many but not all of the participants started experiencing more productive interactions with their advisor.

Describing Interaction with Advisor

Trusting Advisor for Making Research Decision

Some participants highlighted the advisor role in the initial phases of their research; Haily stated: "I always talk to my advisor, specifically when I have some ideas. First try to seek his opinions before doing something. I report my results to him, and ask for his feedback." The majority of participants pointed out that learning to define problems is the most challenging part of research, and advisors effectively assisted them in this process. Reza expressed: "My advisor helps me to find a new problem with giving me new general ideas, and helping me refining my own ideas." Making progress in their research, participants discover more linkages and relationships with advisor's initial guidance; Samin described: "My advisor influences all my decisions in the college. I know 100% in my mind that he cares about me, so I trust him. Even if there were some areas that I disagreed with him, it turned out later that he was right." Advisors provide meaningful feedback through monitoring students' progress and having consistent communication with students. Lily expressed: "He knows how to zoom out in students' research and give the research a fresh look… sometimes when you are involved in a research you think you are thinking differently but what happens really is that you are turning around and around initial

point." Ryka had the same experience through consistent personal contact with his advisor: "I have regular meetings with [my advisor], sometimes about three hours, and he gives me general guidelines on my research."

Perception of Role Models

Some participants were eager to find role models, or emphasized the role of their advisor as a role model. Taking part in a conference motivated one of the participants of this study to choose his research community members as role model, being encouraged to be part of that community. Samin stated: "We all volunteered in a conference… It was the first conference I was involved in… and I enjoyed so much seeing people from literally every corner of the world… All these people were just excited and passionate about their research… They all were sharing their passion…I was just like this is amazing, I want to be part of this!" Haily, who was planning to have an academic job in the future, admired his advisor's teaching methods and talked about the desire to use them in his future career. "He [the adviser] is a very good teacher. He spends substantial time to elaborate details about each concept in his classes. I'd personally try to adopt his teaching norms."

One of the participants brought a new insight to this subject; the advisors, who also play the role of a role model for their students, do not necessarily play a positive role in shaping students' behaviors. The participant stated: "His [advisor's] bad behaviors are being propagated to students in the lab, we as students warn each other in the lab when we behave like him. We see some people [students in the lab] that they are almost there and are not aware of that." He further added: "We keep giving each other feedback to make sure we are not falling in that trap!" According to what the participant stated, students may choose advisors as role models without

even being consciously aware of their role. Furthermore, a group of students may either consciously adopt or resist the advisor's patterns of behavior.

Referring to Opposite Cases

Participants satisfied with their relationship with their advisors chose different ways to describe how they perceive advisors' professional behavior. Some described positive characteristics of advisor or the interaction. However, some compared their own interaction to students with unpleasant experiences. Keyana stated: "One thing I learned from my advisor is to be professional. His behavior does not depend on who you are; he behaves everyone the same. Everything is about research." Further adding: "I know some of my friends receive emails from their advisor that the professor talks down and threat them with losing financial support. But my advisor is not like that. He always tells me just keep working, and don't worry about funding." Ali uses the same strategy to describe his advisor's professional behavior: "In one word I would say professional. He is friendly when it needs to be, he never is unfriendly, never uses harsh words, but he encourages you. When there is a deadline, he never insults you, or uses harsh words to get you to the deadline, says everything in a nice way. He never makes you feel bad after you speak to him." When the researcher asked to elaborate why he chose this way to describe the interaction with his advisor, he stated: "I have never had one [an advisor that uses harsh words] but I know students that have such advisors." Likewise, Nicki used the same strategy, stating: "My relationship with my advisor is good, it is not excellent, but that's good". He elaborated further: "My advisor does not talk with me in a harsh tone. He encourages me, and never questions me."

Inconsistent with American Work Values

Some participants discussed issues interacting with advisors that they felt were not necessarily a reflection of appropriate values in the engineering labs. Dena, who had decided to quit the PhD program, stated: “He [the advisor] told me many times that you are not a PhD material… I was overwhelmed… there was too much mental pressure from his side.” He discussed how he constantly felt uncomfortable interacting with his advisor: “He kept insulting us in the meetings, shouting, using vulgar language, giving us so many negative remarks to bring us down.” Some advisors use financial support as a tool to push students to work. One of the students stated: “He [the advisor] told us that you should beg me to get an RA because the money is limited.” He further added: “he prefers international students to domestics because he has the money as a tool to control them.” Another participant also believed: “The advisor shows himself very nice when we have a visitor from university or our community, he shows himself and treats us in a classy way and very different from the original way he treats us.” One student also mentioned that his advisor uses visa as a tool to push him to work more and faster: “Every week, he threatened me that if I couldn’t generate any result he would send an email to cancel my contract and visa.”

One of the participants stated that his advisor has a business mindset towards academic work rather than a scientific mindset. The participant mentioned: “One of the problems is the advisor's mindset which is a business mindset rather than a scientific mindset. So he mostly relies on a mass production of papers, and therefore getting more credibility, and therefore getting more funding. He gets more students, more papers, so on and so forth.” He also discussed the risk of having such a mindset: “That puts lots of pressure on students and encourage them to generate outputs with low quality. Usually students who are in the second year and do not have any

publications are in the danger of losing their position". He further added: "I don't see him behaving or interacting with American culture values, but there is one thing common, which is his capitalistic approach to research and life." He believed: "He [the advisor] is here because of the huge money he is bringing in. The system which is too much money-based allows him to be like that. If he leaves, the department would collapse."

Obstacles to Managing Advisor's Expectations

Advisor Aims High

Some participants mentioned that their advisors aimed high, causing them to experience long work hours, stress, and also receiving unfair criticism. However, most but not necessarily all participants associated the advisors' high expectations with positive feelings. Effects of advisors' aiming high on students' performance varied from one participant to another, to some extent echoing the quality of student-advisor interaction. Amir smiled and calmly acknowledged how on some occasions she has not met her advisor's expectations. However, it turned out to be acceptable to the advisor, stating: "Sometimes he expects you more than what you can do, but when you cannot meet his expectations he is still fine." Ali expressed that staying long hours on campus was a result of his advisor's high expectations. However, he further added: "My advisor has very high expectations from all students, he is very well-known in his field so he expects his students a quality work," The advisor ensured that all students were treated equally and the expectations may lead students to achieve successful outcomes. Lily appreciated that his advisor aimed high so that enabled him to achieve successful results and high confidence. He stated: "My adviser aims very high… that actually helps a lot in terms of your self-esteem. Maybe if he didn't have this many of

us including me, wouldn't able to submit in top conferences." Samin expressed that his advisor provided him opportunities to submit articles in high ranked journals and conferences, while the advisor had been significantly supportive, stating: "he expects a lot, but also gives you a ton [of support]." By contrast, Dena also experienced his advisor's high educations, but did not feel supported to achieve those high expectations. Dena described how his advisor's high expectations did not match his background knowledge and experiences, as well as caused him being unpleasantly and unfairly treated. Dena stated: "I only had a bachelor when I came here, after I missed a deadline for a conference submission at the month 5 of entering the program, he gave me many harsh comments, and all of our conflicts started at that point."

Unreasonable Time Demands

The majority of students mentioned that they work around 50-60 hours per week, inconsistent with the number of hours they are required by the university to work as graduate teaching or research assistants, according to their contract. Ali stated: "One problem is I work over 20 hours every week, but I only get paid for 20 hours a week. On average I work 45 hours per week." Students need to spend time working in labs or classes to satisfy their contract obligations for graduate teaching or research assistantship, in addition to working on their own research. Ryka mentioned:" The time is very limited because I do not have enough time to spend on my own research." This workload requires students to stay long hours on-campus, work on weekends, and work from home. Ali elaborated further: "Some days I am on the campus for over ten hours working. I try to work only one day of the weekend if I need, but is has happened sometimes that I have worked on both days." Some participants work at home in addition to the time they work at lab. Reza stated: "On average I work 1-2 hours from home daily." Lily expressed how the work

pressure impacted his life: “The pressure of work is impacting my entire life, how good I can sleep, how much time I can spend with my wife, even whether we can go to a vacation or not.” Sometimes the workload and irregular habit of working caused participants sleep deprivation. Nicki stated:” Some days I don't sleep at all, sometimes I don't sleep for 50-60 hours.” One participant received phone calls at nights from his advisor. Ryka stated: “Sometimes he calls at nights, sometimes you receive emails from him at 3am”. Some participants even need to stay in labs during night. Nilla mentioned: “Every single one of us has a sleeping bag in the lab to use when we have deadlines.”

Lack of Collaborations

Participants who experienced a lack of research collaboration with their colleagues did not have sufficient opportunities to learn research norms. They also lost possibilities to interact with colleagues, and, as a result, did not receive any assistance from them to understand their advisors’ expectations better. Amir expressed: “When there is not any shared project, there is no need to interact with others, and you wouldn't have any expectations from them.” Haily, who experienced a lack of collaboration, stated that he experienced difficulty progressing his research and he “expected to have a chance to work with the senior members of the lab in their on-progress work.” Haily emphasized the role of working with a senior student, that could have assisted him in learning research norms, and learn to identify different challenges and research topics in the field. Haily also elaborated the role of collaboration as a medium to engage international students to interact with other students, stating: “International students need to have some shared interest to interact. Working on the same projects facilitate this interaction. At this point there is not such an interaction [in our lab].”

Some participants talked about how their advisors' inconsistent approaches towards collaboration impaired the efficiency of their research. They mentioned that advisors encourage students to collaborate sporadically when there is a need to publish numerous papers, and discourage them from doing so when they think students may work with each other or other professors, or publish without letting the advisor know.

Work Pressure Around Deadlines

The majority of participants described experiencing significant changes in daily work schedule, amount of interactions with advisor, and stress level, due to increasing pressure at work close to certain deadlines.

Amir stated: "When a deadline is coming we meet every day, otherwise I try to find him for a meeting maybe every week or every other week." Lily described he usually worked 17 hours per day when he had deadlines: "Before the deadline for about two weeks I am in the lab from 10 am to 3am in the next day." He further explained about his norms on weekends: "Weekends the schedule is the same [as workdays] when it is close to deadline, I go to the lab, you can treat them like the weekdays." Nilla thought that deadlines make him "really productive" but they "are not necessarily healthy." He added that he and his labmates "stay in the lab from two weeks before the deadline, and just leave for sleep."

Participants receive stress from advisors when there is a deadline. Raika stated: "when there is a deadline or we have to send a report he has so much stress until the work is done, that puts so much pressure on students, especially for those who just entered the lab." Dena had the same experience about his first deadline, stating "Before that deadline, for two months I just daily came back home for seven hours just to sleep." He described the consequences when, despite the

hard work, he missed the deadline: “I missed a deadline and then received many harsh comments from him. So I thought if I don't quit soon, I am in danger of having a serious mental illness.”

Unwilling to Receive Criticism

Some participants experienced difficulty having productive scientific discussions with their advisors. One participant described how he received harsh comments after an attempt to convince his advisor in a discussion, stating: “My advisor is not tolerant of criticism, I have the experience of arguing with him about one of his comments on my paper, I wanted to know his reasons and then received harsh comments from him.” Another participant talked about how one of his labmates was confronted by the advisor for taking an opposite position in a scientific discussion. He stated: “my advisor was angry of one of the students because in a scientific discussion the student disagreed with him, the advisor wanted him to write in an email to him saying ‘I am wrong and you are right’.”

Another participant had difficulty asking his advisor to provide him required accommodation for his research. This participant expressed how he received frequent intolerant responses when he was trying to request:

> I had solved the mathematical model of the problem and made the simulation, but I was not able to implement it. The reason was the robot I was working with was too old, even the company that had built that robot verified in email that this robot is not build to solve this problem. I communicated with him several times, but he never accepted. He kept telling me I don't have money to buy a new robot, you should meet the deadline with this robot. I explained him a few times the downside of his decision. He got angry.

Ryka described his advisor as a person who was regularly under too much pressure of deadlines. Ryka expressed he was not willing to express a counter point of view when the advisor was stressed out: “When my advisor is stressed out, it's hard for him to listen to you, especially when we have time limits.”

Difficulty Reaching out to the Advisor

Some participants explained that reaching out to the advisor is a challenge. Although Amir described that she has not any major issues interacting her advisor, she stated “My advisor is a graduate coordinator so mostly he is busy with his administrative job and it is hard to reach him, it is the main problem. Once you find him everything is fine.” Keyana described his advisor as respectful, hard-working, and punctual, but stated that his advisor is so busy because of his administrative job in the department. He usually cannot be reached during business hours. However, when Keyana tries contacting him after hours he is usually successful. Ali also mentioned: “My advisor is very busy so sometimes it is hard to reach him for a meeting, because he is a department chair. That is the biggest challenge I have with him.” Nicki explained another reason for lacking regular meetings with his advisor: “He stays at home a lot, because of his age. So it is hard to find him at his office.”

Experiencing a Transition Phase to Learn Working Independently

Labmates Support Each Other

Working long hours in a lab with individuals who have experienced, or may experience, similar challenges throughout the program creates bonding among students. Participants in this study talked about many positive experiences interacting with their labmates. Students support

each other in different ways; one way is emotional support. The emotional support students provide for each other help them cope the pressure of graduate school; as Amir explained: “The interaction with labmates is okay— It’s fine. The best part of the interaction with labmates is you can share your frustration because they are people who know what you are going through.” Lily concisely expressed that forming strong emotional relations with coworkers is an inevitable result of engineering graduate work pressure: “You are spending more time at lab than you spend at home, so over five years you guys are forming kind of a family.” Participants also help their labmates with sharing technical knowledge. Labmates initially seek help from each other as the first contact; Amir stated: “When I need help, mostly I ask from fellow students. When I have problem in coding I rarely go to my advisor to ask, preferably I ask from any student in the lab who have worked on that kind of the problem.” Ryka has the same experience: “I have interaction with everybody in the lab. We have a friendly lab environment and constantly learn from each other. For example, when I have coding problem I ask from help other students who are more experienced than me”

One of the participants described when conflicts occur between advisor and students, students tend to support each other; as he stated: “I have learned that all of us in the lab should back each other in the time of difficulty…” Backing labmates in conflicts highlights students’ bonding, as well as an urge for secure relationship with advisor, this participant elaborated: “It's gonna happen to you next.”

Participants described that students support each other with spending time providing information, analyzing each other’s code, or even assisting in the coursework. Participants in this study shared many occasions they have had assisted their labmates when there was no plan for a formal collaboration. Keyana described: “Each person in the lab works on their own projects, no

two people work on the same projects. However, as fields are the same, we reach each other and seek help, most of the time they have ideas that helps you"

Ali, as a domestic student, supports his international labmates with providing writing assistance "One of the international students in the lab has problem conveying his ideas so sometimes he reaches me and I help him through to pick words to better communicate his ideas."

Learning from Labmates' Experiences

The lab environment, which is a shared workspace for several students having the same or different advisors, allows students to learn directly and indirectly from each other. Participants, specifically in the first years, have questions, confusions, and doubts about how to interact with others. Lily believed: "Similar to other relationships, it takes time to learn about [the advisor's] character. When you begin your PhD nobody will tell you about how you interact with your advisor." Participants in the study learned various behaviors, practices, and skills from their labmates, from experiences of working on the same computer code in the past, to managing relationship with advisor. It is not necessarily only other students' positive experiences, which give participants ideas about interacting with others; arguments, unsuccessful collaborations, and failures assist participants to grow. As Nilla stated "I learned a lot from other labmates' stories and their arguments over authorship. I learned what not to do when collaborating with others." Interactions among other labmates constantly inform participants of how to communicate with others, or redefine their boundaries. Lily described: "Now I am more hesitant in terms of interacting and collaborating with others. If it was the first year, anyone who would come and ask 'hey collaborate', I would say 'sure', now I put background of that person and think this guy did this to another person… Now I have more items to check before being open to new decisions."

Participants seek senior students' advice if they need help solving technical problems and as when they have communication challenges. Nilla described how approaching senior students assisted him to have more appropriate communication with his advisor: "…I always talk to senior students in the lab and ask them how to interact with him to not get into trouble." Through working and having discussions with a senior labmate, Samin experienced learning new research skills: "I didn't know anything about research…having a critical eye helps you better understand the materials and see weaknesses you may improve by your own research. I learned to be critical of papers I read. This is what [my labmate] really helped me to learn and understand." Ryka described how he, as a senior student, shared his own experiences with his labmates: "We have the same data, and different projects. But we are all in the same field so sometimes we have common papers to read, and I have helped them through writing codes, finding papers, and doing research"

Ali, a domestic student, shares a variety of knowledge and experiences with his international labmates, including non-academic experiences or cultural information: "In my lab, most of the students are international students, so sometimes the questions are about renting a house or buying a car, which international students might not know, but domestic students might have a better understanding of."

Learning Through Trial and Error

Participants discussed how they practice conducting research through trial and error. Participants who arrived at the PhD program directly from their bachelors study expressed difficulty understanding key concepts of research. Keyana stated, "In the first year, I didn't have any idea what research was, I even did not know the meaning of key terms of research like model, literature, and references. I had to go through it myself. I didn't know the model is supposed to be

mathematical or physical. It took me one semester to understand the model was mathematical, and it was about to transferring your ideas to mathematics." Specifically, when there is no collaboration or shared projects participants were more dependent on advisors in the learning process. Keyana stated: "My advisor was repeating the exact same thing over and over for a year, till I learned and started showing progress." The progress through learning by trial and error appeared to be slow. As Keyana explained: "It [progress] was a very slow start in first year, but then it was increasing exponentially."

One cause of participants using the same procedures repeatedly to discover the best answer was advisor's insufficient guidance Ali stated: "Sometimes when I or other students in my lab ask him a question and expect him to give a really good answer, he gives a very general answer or a general advice about doing research, and not a specific answer." Ali articulates his advisor's approach to addressing students' questions as "It could be happening because he wants students figure out the answer, or the alternative is he might not have time to answer the questions to the students."

Moreover, doing trial and error causes participants to feel ineffective. Nicki stated: "There are so many trial and errors in my work; I wish I had the outputs of a fresh mind on my work." As an outcome of this continuous process, Ryka explained: "During the PhD program, I learned to be more patient, you find a problem and think you have find a solution, after a while you face new problems in the process, so you have to be consistent and patient."

Becoming Problem Solver

Participants discussed how the learned skills in the PhD program assisted them to become problem solvers. Samin explained how he learned from his advisor to have "a more active

approach" towards problems, and learned to "do pre-plan for research and even for daily schedule." Through interacting with advisors and colleagues, participants learn communication skills which may help them interact with others, and also encourage them to be accountable and responsible in areas beyond research, Lily stated: "The other very big lesson is to be patient and being manager of your work, your life, and your adviser." He stated how he practiced professional interaction with his advisor: "You need to be able to control it [the interaction], and manage it while remaining professional."

Participants talked about gaining new problem solving skills as well as more confidence when approaching new problems. Ryka stated: "My motivation to start the PhD was to learn more knowledge in my field. It is not what I expected but still good… Now I've learned that PhD is not about collecting lots of knowledge but learning how to solve problems. I learned that the PhD goal is to train you to do research, think out of the box, and define solution for different problems." Reza stated: "I have gained academic skills like how to do research independently, how to learn by myself, how to approach different scientific problems that I have not never met before." Ryka expressed the same idea, stating: "I learned to manage my stress and be more relax in the process of learning, for example when I see new problems. Because I have found out that eventually I will learn it."

Challenges of Studying in a Fast-Moving Field

The fifth theme of this study is provided based on the computer science participants' experiences. Table 5 is the frequency table for Theme Five.

Participants from the computer science discipline discussed how their experiences were affected by the context of their academic field. Participants described that researchers in the field,

including doctoral students, compete to beat state of the art. Computer science scholarly papers are focused on specific ongoing problems in the field such as cyber security, data mining, algorithms, and quantum computing. The purpose of researchers is to develop new solutions to the ongoing problems and present new results with higher accuracy to incrementally improve current solutions. Participants described that the research community associated their outcomes with their number of publications and citations. Some participants described how their senses of achievement significantly depended on having publications.

Table 5: Frequency of Computer Science Participant Experiences

Major and Minor Themes	Typical	Frequent	Variant
Challenges of Studying in a Fast-Moving Field			
Rapid pace of research	X		
Defining problem is a challenge	X		
Intense competition to beat state of the art	X		
More publication signifies more success		X	
Publishing overshadows sense of achievement		X	

Note. Typical = 4-5 participants; Frequent = 2-3 participants; Variant = 1 participant

Rapid Pace of Research

Researchers in the computer science field need to constantly upgrade and renovate their knowledge. Participants explained how rapid changes in the field required researchers to act and respond quickly. Lily described the significance of being a fast learner in the computer science field:

> "You should learn how to quickly learn about new topics. You should teach yourself if a new topic comes on, you need to learn enough about it in at most three weeks. You can think about it like kind of a skill that if a new topic emerges in your area of research you cannot wait for a year to master it. Because the field is very hot right now…you cannot

> afford waiting that long. Because all the papers would be published, and when you catch up one year from now, people would move to another topic.

Haily talked about several opportunities that each year computer science researchers have to publish and present their work. These opportunities require students to work hard and under constant pressure "The pace of research is quite high. You have to be really involved in your work to make it to a conference. There are three or four major conferences in a year in our field, which they will come on one after the other…You really have to work hard to be able to publish in one or two of them."

Participants explained that due to rapid changes in the filed computer science, researchers submit their works ahead of publishing to ArXiv, which is a repository of online scholarly papers. That is, to maintain the ownership of the idea and secure the credit of research. Meanwhile, other researchers learn about the progress of solving each problem through reviewing ArXive submissions. The papers submitted to ArXiv are not peer-reviewed but can be cited in research studies.

Defining Problem Is a Challenge

Computer science participants discussed different aspects of their work in which defining problem was described as the most challenging part. Problem definition phase was described as a difficult and tedious process by Amir: "the worst part of the work is when you do not have any problem and you just keep doing blind literature survey." Haley also described how problem definition is complicated, acknowledging lack of interest in reading: "There is a lot of reading

involved which can be boring and frustrating. It is very easy to lose focus when you are on that level of reading." Emphasizing the difficulty of problem definition in computer science research, Haily stated: "The main challenge is the research itself." Lily viewed "Coming up to a new problem that nobody has thought about it before" as a challenge that eventually would give him feeling of triumph. Likewise, Reza acknowledged that defining a new problem is the most challenging part of the work, although he liked it the most.

Intense Competition to Beat State of the Art

Researchers in the field experience a constant pressure prior to publishing their research. Amir explained the risk of losing the research outcome in any stage of the work due to the intense competition among researchers, stating that: "I get frustrated when my code is not working, results are not good enough, when you are doing literature survey and you figure out that this problem is already solved, or when you are working on a problem and another paper get published and you realize that somebody has just done it."

Lily talked about the intense competition in the field and the feeling of triumph he achieves after successfully beating state of the art:

> We have many problems in our field that so many people are, at the same time, working on them. They are the existing challenges in the field, when you come up with an idea on how to solve a problem; of course, you have to compete with other people. The moment you see your method beating state of the art, that time you have good sense of achievement.

Additionally, one partcipant criticized some research community norms, which significantly valued research that beats state of the art rather than the insights researchers could provide to expand other aspects of research in the field. He stated:

> Knowing that everything is being evaluated based on the outcome rather than the insight you can provide. You can provide a research work that sheds light on a part of research problems, but that with high probability will not be published... simply because you are not beating state of the art... So this too much focus on reporting higher numbers and better results is what I really don't like.

More Publication Signifies More Success

Research community, advisors, or personal preferences were found among the main elements that directed participants to publish more research papers. Lily talked about some ineffective norms of the research community that were focused on generating more publication. He stated that: “Too much focus on having more papers and more citations… I see it in my own research environment that it pushes people towards kind of doing everything to get to that point.”

Nilla criticized the way the advisor encouraged students to have more publications, and believed that advisor followed his own benefits in encouraging students to publish more: “One of the problems is the advisor's mindset which is a business mindset rather than a scientific mindset. So he mostly relies on a mass production of papers, and therefore getting more credibility, and therefore getting more funding. He gets more students, more papers, so on and so forth.” Nilla also believed that too much focus on publications provokes anxiety among students and

decreases work effectiveness, stating: “That puts lots of pressure on students and encourage them to generate outputs with low quality.”

Amir acknowledge her own preference when the researcher asked what factors influence her decision making processes regarding research. She laughed and responded: “Can I publish it?”

Publishing Overshadowed Sense of Achievement

Some participants’ inner satisfactions were significantly dependent on having publications. Amir talked about how she ascribed meaning to her PhD experience, stating that: “Research and publication is the main reason that I feel bad or good about the state of my PhD.” The final theme with how Lily described his feelings aftermath of missing a conference submission deadline despite so much endeavors: “I felt like I was a track and field medalist who suddenly has lost both of his feet in an accident.”

Conclusion

This study examined doctoral engineering students’ lived experiences of socialization with their colleagues and advisors. The researcher interviewed eleven doctoral students from electrical engineering, computer engineering, and computer science. Participants came from various regions, including North America, Asia, India, and Middle East. The study found five emergent themes of how participants generated meanings from their lived experiences as doctoral engineering students. Participants experienced difficulty learning norms of research and PhD program due to a lack of clear expectations and employment skills. Advisors' professional behaviors encourage students to consciously choose the advisor as a role model. Advisors’ high aims put pressure on students to discern advisor's expectations, this situation exacerbated due to a heavy workload and

time pressure near the deadlines. Heavy workload which required participants to stay long hours on campus was reported to be related to their research assignments and not work related to courses or teaching assistantship. Particularly, computer science participants experienced pressure due to rapid changes in the field. Seeking support from labmates and learning from their experiences, and also individual working and use of trial and error advanced students to become independent learners.

Compare and Contrast between findings and Researcher's prior beliefs

Table 6 illustrates which findings corroborated the researcher's prior beliefs, which findings contradicted them, and which findings were different from her prior knowledge.

Table 6: Compare and Contrast between findings and Researcher's prior beliefs

Finding	Comparison to prior beliefs	Researcher's Prior beliefs
Difficulty learning norms of research and PhD program due to a lack of clear expectations and employment skills.	Different	This finding was new to the researcher
Advisors' high aims put pressure on participants to discern advisor's expectations	Partially Corroborates	The researcher's prior beliefs related to work pressure was about international students, however, the findings indicated the same results for domestic students
Heavy workload required participants to stay long hours on campus	Corroborate	Engineering doctoral students work hard and staying long hours in labs
Hesitancy to share concerns	Different	This finding was new to the researcher.
Through trial and error and seeking assistance from labmates, participants learned to work independently	Different	This finding was new to the researcher.
Students learn from labmates' experiences and support each other.	Contradiction	International students have limited interactions with their labmates.
Participants were largely uninterested in integrating with the larger University community	Different	This finding was new to the researcher.
Participants viewed their senior labmates, advisors and professors, whom they worked for, as "role models"	Different	This finding was new to the researcher.
Participants in this study expressed reliance on their advisors' guidance in the process of making research decisions.	Different	This finding was new to the researcher.
Experiences of some students were affected by the context of the field.	Different	This finding was new to the researcher.
Most of the international participants explained that they typically had labmates from the same regions of the world.	Partially Corroborate	Partially corroborates with researcher's prior belief that students may be hired by faculty from the same region.
Most of the participants reported feeling disconnected from the broader campus environment, but they suggested that work requirements were more important than socializing across campus.	Different	This finding was new to the researcher.

In addition to the general beliefs about doctoral students in Engineering, my bracketing indicated a number of beliefs specific to international students. Most but not all of these beliefs were corroborated by the data collected in this study. International students with teaching or research assistantship are required to work more than twenty hours per week, and are paid biweekly for a twenty hours workload.

- Majority of international students are full-time students and have full time jobs in the College like teaching assistant or research assistant.
- International students may feel extra work pressure due to risk of losing financial support and visa.
- Impaired enculturation may result in changing advisers and research areas
- International students in doctoral engineering programs typically have low English language proficiency.

International students have limited interactions with their family in their home countries due to difficulty in visa issue. The findings from this study are discussed in Chapter 5.

CHAPTER FIVE: DISCUSSION

Introduction

In this chapter, first, the researcher discusses how the findings of this study corroborate, contrast, or extend previous research literature in Chapter Two. In the next steps, the implications of research in engineering education and higher education are discussed, as well as the limitations of the study, and areas for future research.

Discussion of Findings

The purpose of this study was to answer the following research question:

What are the lived experiences of doctoral engineering students' socialization with their advisors and colleagues?

The findings of this study indicated that participants experienced difficulty adjusting with norms of the PhD program from which some participants did not have a clear set of expectations prior to starting. Describing different aspects of the PhD experience, participants described challenges faced due to being hesitant to share concerns with advisors and a lack of work experience. Participants described how their work is influenced by their colleagues' support, unreasonable time demands, and heavy workload around deadlines. Through trial and error and seeking assistance from labmates, participants learned to work independently and become problem solvers. Additionally, Computer science participants acknowledged that the field's rapid changes and research competitive environment required participants to learn fast and publish more scholarly papers.

Corroboration with Previous Research

The majority of this study's findings corroborated with previous research, which focused on socialization, socialization in higher education, socialization of doctoral students, and faculty-student interaction in higher education. Most of the participants in this study described how they usually approached their labmates and specifically more experienced students to seek support. This finding is consistent with research that suggested that organizational socialization is a "process by which newcomers make the transition from being organizational outsiders to being insiders" (T. Bauer et al., 1998, p. 707). Moreover, most participants in this study described they reached out to their labmates to ask questions about coursework, coding, and authorship of papers. The latter is also consistent with findings of a previous research that suggested doctoral students are constantly in the process of exchanging information and sharing experiences with each other (Bragg, 1976).

The finding that international doctoral students in engineering were largely uninterested in integrating with the larger University community was consistent with Tierny's critique of "modern" theories of socialization in higher education (1997). The main assumption that underlies the modern approach of studying culture and socialization is that culture of an organization is cohesive and understandable. The modern approach presented two viewpoints to explore culture of a higher education organization. In the first viewpoint, researchers acknowledge that each college has a specific culture which differs from others. The goal of this approach is to establish a taxonomy of cultures that reflects the diversity among colleges. In the second viewpoint of the modern approach, researchers study culture of minorities within each college to explore reasons for deficiencies of specific racial or ethnic groups (Tierney, 1997).

Additionally, some participants described that they viewed their more experienced labmates, advisors and professors, whom they worked for, as "role models" (Merton, 1957). Three

participants explained some of the advisors' values and practices that they liked the most, such as effective teaching methods, nonjudgmental attitude towards students, and critical thinking and problem solving abilities. The participants expressed their interest in adopting those values and behaviors in their future academic work. They also explained strategies they have adopted to learn those values and practices, such as voluntarily auditing advisors' classes in spare time and seeking variety of professional advice from them. The participants' experiences implies some participants viewed the advisors consistent with research in socialization that suggested a five-step process of how a socialized person views interaction with a role model: (1) Identification and observation of a role model (2) Imitation of specific behaviors exhibited by the role model (3) Feedback and evaluation on the imitated behaviors. (4) Modification or refinement of the behaviors that were evaluated (5) Internalization of values and behaviors from the role model (Bragg, 1976, p. 7).

Similar to a finding of a longitudinal research by Austin (2002) on socialization of graduate students, this study found that doctoral graduate positions provide research assistants and teaching assistants with significant socialization opportunities to observe faculty work and interact with advisor and peers. Likewise, most participants commented favorably on interactions with their labmates. Moreover, some participants reported difficulty reaching out their advisor or receiving regular feedback, as some participants of the Austin (2002) whom described experiencing insufficient feedback and mentoring from advisors. Furthermore, some participants expressed they become problem solvers as a result of the research skills learned in graduate school. This finding was consistent with Austin (2002) who indicated graduate students gained confidence in doing research. The latter finding also supported Baird (1995) who found graduate students' skills of problem definition and applying appropriate methodologies will be enhanced in graduate programs.

All participants in this study expressed reliance on their advisors' guidance in the process of making research decisions. The findings support the conclusion of the Cole and Griffin's research (2013), who suggested graduate students obtain acquired research knowledge in their field through interaction with advisors.

Consistent with a qualitative research that investigated lived experiences of Indonesian doctoral students in the U.S. in applied sciences, science, and engineering, this study found excessive work pressure and insufficient mentoring as a potential source of conflict between doctoral students and advisors (Mukminin & McMahon, 2013). However, by contrast to that study that all the students were first year students, none of the participants in this were in their first year. Additionally, none of the participants of this study reported any lingual barrier or unfamiliarity with classes and college as a source of lack of academic involvement.

Furthermore, the findings corroborated with those in Williams's (2002) study where norms and behaviors were reported various in different engineering disciplines. Similarly, analyzing experiences of computer science participants led to emerging a fifth theme in this study in which the experiences of doctoral students in computer science were affected by the context of the field. Computer science students described that rapid changes in the field created a highly competitive research environment which pressured participants to publish papers in prestigious conferences. By contrast, the doctoral students in electrical engineering did not report that rapid change and high levels of competition were important aspects of their experience.

The fifth theme for computer science students' work habits, and also the finding that engineering doctoral students typically work individually in their lab, but socialize with labmate to learn professional habits and norms of their field, is consistent with research by Golde (2010) that suggested doctoral students gain professional expertise in each academic discipline through

distinct socialization norms and practices. Additionally, the aforementioned findings are consistent with the notion of Cronon (2006) who explored work habits and shared values of doctoral students in History, and consequently suggested that doctoral students in various disciplines have distinct "shared ways of asking questions, interacting with each other and making sense of the world" (Cronon, 2006, p. 330).

The finding that participants sought support from their more experienced labmates to learn how to interact with their advisor or discuss authorship with their colleagues is similar to findings of research (Gerholm, 1990) that explored communication methods and norms of behavior in an anthropology department and proposed that students in graduate programs acquire tactic knowledge to interact with their supervisor and research group in different settings.

The finding about work norms of students in the engineering labs is consistent with the finding of Golde (2010) study where doctoral students in Science, Technology, Engineering, and Mathematics (STEM) fields have their own socialization strategies due to working in a lab setting, collaborating with their colleagues in research groups, and a lack of options to choose dissertation topics.

Contrasts with previous research

The findings of this study contradict earlier research suggesting that international students had difficulties with social integration (Kim, 2002). Most of the international participants explained that they typically had labmates from the same regions of the world. They also described building their own support system together and reinforcing their own culture within the Department and College. Therefore, many of them may not be likely or feel a necessity to interact with students out of the College. This argument is in contrast with a conclusion of a research that

suggested “integration can mean something completely different to student groups who have been historically marginalized in higher education” (Hurtado & Carter, 1997, p. 4). That means doctoral international participants did not integrate more widely into the University due to a lack of motivation to interact with other students, but due to the work environment in their fields. Except two participants, none of them were involved in campus extracurricular activities or had friends out of the college.

By contrast, the experiences reported by these participants was more consistent with what Tierney describes as “postmodern” socialization, in which students bring their own culture to the college to co-create new socialization dynamism (Tierney, 1997). This postmodern view of socialization rests on three criticisms of the modern approach: (a) the assumption that individuals “acquire” values and norms. (b) viewing socialization as a one-way process (3) socialization as a set of pre-planned actions. The postmodern approach suggests that socialization in higher education is a reciprocal process in which minority students learn from the college and have influence on it (Tierney, 1997).

By contrast to Bragg’s (1976) point about that a five-step process of how a socialized person views interaction with a role model, one participant criticized effects of long-term interaction with advisor. One of the participant described how students in their lab have a casual agreement to help each other avoiding replication of some of the unacceptable advisor’s patterns of behavior, on which students were not comfortable with the incorporation of advisors’ behaviors into their own norms. ,

Most of the participants reported feeling disconnected from the broader campus environment, but they suggested that work requirements were more important than socializing across campus. These doctoral engineering students worked long hours, alone with a computer in

a cubical. This finding seems to be different from Kim's (2002) research which suggested that sojourners' experience of adaptation follows the theory of *U-curve hypothesis* that includes three major phases: (a) fascination to the new culture (b) disintegration, and (c) recovery (Kim, 2002). While participants were aware that they were disconnected from the rest of the University, they had little time to think about it or worry about it.

How This Study Adds to the Body of Research

This phenomenological study of the lived experiences of doctoral students in electrical and computer engineering adds several insights not noted in previous studies. While most participants in this study were international students, the findings did not show a lack of compatibility and similarity between international and domestic students' experiences. As noted in the study, almost all participants described experiencing long hours working in the college, work pressure around deadlines, receiving support from labmates, and some barriers communicating with advisors. However, the data did not show that participants were experiencing limitations learning work norms and interactions with their advisors due to differences in countries of origin. Some participants described how working with senior students in the first year significantly assisted them to learn research norms. Additionally, some students described observing other students' interactions with advisor, so that helped them to interact more effectively with advisor. That is, doctoral students learn work norms from a variety of resources including other graduate students, and perceiving the advisor as the only or even primary "role model" for them is inaccurate.

The findings also suggest that it is not only the discipline that shapes doctoral students' experiences, but the nature of research in that discipline. This corroborates but also extends Austin's (2002) point that that research on graduate education need to look more closely at specific

disciplines. Furthermore, some participants in this study described hesitancy in sharing concerns with advisors, as well as the assumptions about negative consequences of speaking up about work challenges. Some doctoral students who receive financial support from universities or advisors may experience this type of assumptions or sense of fear. However, the assumptions may be reinforced among doctoral students in the fields of electrical engineering, computer engineering, and computer science due to their involvement in research projects managed by advisors that typically contribute significant amounts of funding to universities. Universities' increasingly rely on these funds.

Practical Implications

One of the practical implications is the importance of universities being more clear with potential graduate students in engineering fields about features of graduate research assistantship jobs, such as mostly working on their own, heavy workload, and long hours of staying in the labs. Helping prospective applicants will help applicants for admission to doctoral programs to form realistic expectations of what they will be required to do in the next few years. Moreover, the findings benefit prospective or current doctoral students with providing a deeper understanding of PhD life, and other students' challenges and problem solving approaches.

Another implication is an essential need of a system to effectively supervise professional behaviors of faculty advisors' working with doctoral students. Findings suggest that some doctoral students experienced pressure to meet advisors' expectations due to advisors' lack of regular mentoring and unreasonable time demands. Above all, there were doctoral students who reported being treated wrongly as a result of their advisors' inconsistent values and inappropriate behaviors.

Furthermore, teacher preparation mechanisms need to be improved in engineering colleges. Some participants reported that main job of graduate research and teaching assistants were focused on doing research. That may imply that preparation of teachers at electrical and computer engineering colleges is an overlooked topic. The latter may not seem to be a recent topic, as it is fully evident in some of the participants' experiences who acknowledged receiving insufficient advising and mentoring from their advisors. This indicates that the Austin's (2002) idea from more than ten years ago is still valid in higher education, that suggested applicants of new faculty positions at research universities are typically required to have competent research skills as an alternative for mentoring or teaching skills.

Additionally, another implication of this study is having the Graduate Student Association actively involved in advocating doctoral students' professional issues, communicating doctoral students' interests and concerns with various stakeholders and decision makers across the University, and informing doctoral students of their rights and responsibilities. A more active Graduate Student Association may raise the possibility of students' having open dialogue about work issues with their representatives.

Study Limitations

The original intent of this study was to conduct an ethnography research to describe how the culture of engineering labs affects doctoral student socialization. However, the researcher quickly learned the difficulty gathering observational data in this environment. The presence of the researcher as an outsider in the labs seemed to be distracting to doctoral students, as students were working in cubicles with little verbal interactions. That distraction made the process of collecting observational data significantly complicated. Moreover, conducting a few interviews

enabled the researcher to identify that participants were more eager to share their challenges dealing with the PhD life rather than to describe cultural norms of the lab. These challenges guided the research to change the methodology from ethnography to phenomenology.

Sampling criteria of this study excluded majority of domestic students in the programs, since they did not have any teaching or research assistantship positions. Thus, the claims of this research about similarities and differences of international and domestic students' experiences need to be interpreted cautiously.

Another limitation of this study was that although the researcher met many female doctoral students in the college, very few of them volunteered to participate in the study. Several female students were approached, but most were hesitant to participate. However, they genuinely helped the researcher by contacting their colleagues. On the other hand, more male students volunteered to participate in the interviews than it was possible to interview. As a result, the gender distribution of the sample is not necessarily representative of the population.

Another limitation is that the participant recruiting method may have unintentionally influenced the findings. That is, participants of this study were recruited through snowball sampling by which participants introduced their friends or labmates to the researcher. Only after the data analysis was complete did the researcher identify pattern among participants' field and year of study; all of the electrical engineering students were early in the program and the computer science students were nearer the end of their program. Therefore, the fifth theme of the findings, that computer science participants feel greater urgency to publish because of rapid change in their field, may be a product of participants' year of study. Given that, the researcher suggests that this finding be treated with caution.

Recommendation for Future Research

Based on the limitations of this study, a few recommendations can be made for future research. Engineering education field needs more qualitative researchers with engineering academic background. Social and academic connections of the researcher to the participants may be taken into account prior to selecting the sampling method. The researcher of this study is an international student with an engineering background, whose husband was a doctoral student in engineering at the time she was collecting the data, albeit in another department. These facts meant that the researcher already had social and academic connections that enabled her to more easily contact and maybe be trusted by potential participants.

Additionally, researchers in future research would need to take into account the diversity of the population, prior to start their research. The researcher also may need to be cautious of the diversity of participants recruited through snowball sampling. In this study, contacted students were more intended to introduce potential participants who had commonalities with in workplace (graduate lab), country of origin, gender, or year of study. Overlooking this fact may decrease the diversity of the sample.

Another area for future research would be to conduct research with similar methodology to describe experiences of various populations based on their gender, country of origin, and year of study. This study also highlighted the importance of nature of research in engineering disciplines. Future research may also explore the experiences of doctoral students in different engineering disciplines. A comparison of findings with this study would provide insight into variety of students' experiences in doctoral engineering programs, and the role of the nature of research on students' experiences.

Another area of consideration for future research would be to conduct ethnography study and examine lab culture of engineering doctoral students. Conducting an ethnography study with the purpose of studying lab culture was the initial intent of this study. However, the researcher faced difficulty gathering usable observational data. The presence of the researcher seemed to distract students in the first and only round of gathering observational data. That was possibly due to participants' individual work by computers in cubicles, low verbal interactions in the labs, and the nature of their work which was coding and needed students put a full concentration on computers. In future research, ethnographers may choose different data collection methods that may allow them to gather in-depth data of doctoral students' socialization process, such as document analysis of digital interactions of doctoral students with labmates and advisors.

In addition to doctoral students' lab culture, it is essential to study how the culture of engineering colleges of which culture of the labs is a part can influence doctoral students' experiences. This study found that participants were significantly disconnected from the college environment. The majority of students reported working long hours in the labs where they had formed support systems with labmates. Studying the mutual interaction of engineering labs and the college may indicate how administrative could develop strategies to involve doctoral students in the college and enhance their sense of belonging to the college and university.

Concluding Remarks

The purpose of this study was to describe experiences of engineering doctoral students. An intended outcome of this research was to provide details about interaction experiences of domestic and international engineering doctoral students with colleague and advisors. Eleven participants

in computer science, computer engineering, and electrical engineering programs voluntarily agreed to participate in in-depth interviews and share their experiences with the researcher.

This study examined how doctoral students' work norms were influenced by their responsibilities as teaching or research assistants, ways students shared knowledge with each other, and approaches they choose to communicate with their advisors. Explaining various aspects of student-advisor relationship, participants reported that they trusted their advisors' decisions regarding their research, however, they were also frustrated by unreasonable time demands and heavy workload around deadlines. The heavy workload was due to research and not teaching assistantship assignments. Additionally, doing research itself was reported as a source of frustration. Participants managed to learn doing research individually after long processes of doing trial and error. Some students expressed collaborating with a more experienced student in first year largely assisted them to learn how to do research from scratch.

Some participants shared they have had difficulty reaching to their advisor and asking their research questions. Students mostly thought that advisors encouraged them to do research without providing sufficient guidelines. Participants typically approached their labmates to ask their research questions, but the assistance was not always revolved around research. Labmates supported each other through doing coursework together, sharing challenging experiences, and backing each other when faced with a problem interacting with advisor.

Cultural differences appeared to play a key role in advisor-student relationship. Some participants, who were international students and had challenging relationship with their advisor, expressed that they interacted with their advisor based on their own cultural values. Some participants were hesitant to share concerns with their advisors, fearing repercussions. Some international participants were about quitting the program or changing their advisors, but were

hesitant to make the decision as they were not sure how the consequences would affect their academic achievements or visa status.

Contrary to prior research, even though most participants were international students, they did not experience significant difficulties with cultural adjustment to the U.S. However, majority of international participants were in favor of having more interactions with domestic students. International student participants' experiences indicated that they had a strong support system with their labmates who were mostly from their region of the world. Participants were typically uninterested in integrating with the larger University community.

Findings of this study could provide graduate engineering programs and university decision makers insights to identify challenges domestic and international engineering doctoral students, who have research or teaching assistantship, may face to meet their advisors' expectations and pursue their academic goals.

Future research would need to investigate relationship between engineering doctoral students and their advisors from the standpoint of advisors to capture the meaning of advisors' experiences, and gain a holistic view of interaction of various agents such as research community and departments that influence the work norms of engineering doctoral students and advisors.

APPENDIX A: IRB APPROVAL

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Sona Gholizadeh**

Date: **February 23, 2016**

Dear Researcher:

On 02/23/2016, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Project Title:	Socialization Of Engineering Doctoral Students In The U.S.: An Ethnographic Study
Investigator:	Sona Gholizadeh
IRB Number:	SBE-16-12029
Funding Agency:	
Grant Title:	
Research ID:	N/A

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 02/23/2016 12:58:23 PM EST

IRB Manager

APPENDIX B: EXPLANATION OF EXEMPT RESEARCH

EXPLANATION OF EXEMPT RESEARCH

Title of Project: Socialization of Engineering Doctoral Students in the U.S.: An Ethnographic Study

Principal Investigator: Sona Gholizadeh

Faculty Supervisor: David Boote, PhD

You are being invited to take part in a research study. Whether you take part is up to you.

- The purpose of this study is to obtain deeper understanding of the research labs culture experienced by engineering doctoral students. An intended outcome of this research will be to provide details about interactions of domestic and international engineering doctoral students and faculty that supports and challenges students' adaptation to doctoral program.

- Participants will be asked to participate in a face-to-face audio-recorded interview with Sona Gholizadeh. The researcher will gather observational data from offices of engibeering students. The participants will be asked to describe how they adapt to the norms and values of the research group and college. The location for interviews will be offices of doctoral engineering students in the UCF college of engineering, including Engineering I (Eng I), Engineering II (Eng II), and Harris Corporation Engineering Center (HEC) buildings, or the office of the researcher (ED 123E) in CEDHP as a secondary alternative.

- The students will participate in an interview that should last from 45 to 60 minutes depending on the depth of responses from the participant. Participants may be asked to verify content of the interview via email, or follow-up interview, or in person interaction at the conclusion of the interviews.

You must be 18 years of age or older to take part in this research study.

Study contact for questions about the study or to report a problem: If you have questions, concerns, or complaints talk to: Sona Gholizadeh, Doctoral Student, Science Education Program, College of Education and Human Performance, (Sona.Gholizadeh@ucf.edu) or Dr. David Boote, Faculty Supervisor, College of Education and Human Performance at 407-823-4160 or by email David.Boote@ucf.edu.

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901.

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